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# In-Situ Burn Gaps Analysis

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Homeland Security

# N O T I C E



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16. Abstract (MAXIMUM 200 WORDS)

The In-Situ Burn (ISB) Gap Analysis Report summarizes the analysis of over 125 post-Deepwater Horizon recommendations related to the conduct of ISB operations. The initial set of recommendations was grouped into affinity areas (Operations, Safety, Research, and Policy) and then further divided into subcategories depending on the focus of the recommendation. The recommendations were reviewed by subject matter experts to determine which would have the most significant impacts on the efficacy and safety of ISB operations; and then to develop the final set of Gap Analysis recommendations. For each recommendation identified in the Gap Analysis, the report provides the following:

- A brief summary of each of the recommendations identified for ISB from the reference documents or general literature search
- The extent to which the recommendation has been addressed or implemented
- How addressing these recommendations will provide more robust and safer ISB operations
- A description of proposed tasks for future research efforts related to each recommendation
- Whether any recommendations could utilize the burn testing capability that is available at the Joint Maritime Test Facility (JMTF) facility located in Mobile, Alabama

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# EXECUTIVE SUMMARY

The In-Situ Burn (ISB) Gap Analysis reviewed lessons learned, technical papers, recommendations from academia and industry, and a wide range of materials published and presented at conferences in the aftermath of the Deepwater Horizon (DWH) spill. During the cleanup operations associated with the DWH spill, responders employed the full arsenal of cleanup techniques and ISB was employed purposefully and on a massive scale. During the period when ISB operations were conducted from April 28, 2010 through July 19, 2010, over 375 significant burns were responsible for removing approximately 220,000–310,000 barrels of oil from the surface of the water.[1]

*Photo courtesy of Alan Allen.*
June 18, 2010 - 16 burns resulted in the elimination of 50–70K barrels of oil from the water.

Figure ES-1. In-situ burns.

The success of ISB operations during the DWH spill response has prompted many in the response community to suggest that ISB techniques should be available as a primary response option versus an "alternative" response option, which is typically how ISB techniques are viewed/applied.

The employment of ISB techniques on the DWH spill resulted in a large body of potential lessons learned. The literature search resulted in a wide range of recommendations across multiple operational, safety, research, and policy aspects. The full list of recommendations was analyzed by subject matter experts and narrowed down to just the recommendations that would have significant impacts on the operational efficacy/efficiency or safety of an ISB operation. In addition to the operational and safety based recommendations, several other recommendations regarding further research and policy gaps were identified as areas that would impact operations and safety. The specific recommendations were grouped into affinity areas to ensure those with significant operational and safety impacts could be documented and addressed in the gap analysis. A number of the recommendations address specific tactics, equipment, and training issues. While these areas need to be addressed and will improve the efficacy and safety of ISB operations, the recommendations also noted that far too little effort goes into using the tools that are available on the right oil, in the right location, and at the right time. The primary recommendations identify and propose additional research and development that emphasizes surveillance and spotting techniques/equipment to keep responders in the heaviest oil concentrations where their operation to skim, burn, or disperse the oil can be accomplished most effectively and without compromising each other's performance.

[1] Allen, Alan; OSPR/Chevron Workshop Presentation, February 15-17, 2011, In-Situ Burn Operations During the Deepwater Horizon Spill.

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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ACP | Area Contingency Plan |
| ACS | Alaska Clean Seas |
| ADM | Admiral |
| AIS | Automatic Identification System |
| AL | Alabama |
| AMOP | Arctic and Marine Oilspill Program |
| API | American Petroleum Institute |
| ASTM | American Society for Testing and Materials |
| ATSDR | Agency for Toxic Substances and Disease Registry |
| BOK | Body of Knowledge |
| BP | British Petroleum (oil company) |
| BSEE | Bureau of Safety and Environmental Enforcement |
| CDC | Centers for Disease Control and Prevention |
| CFR | Code of Federal Regulations |
| CG | United States Coast Guard |
| COMDTPUB | Commandant Publication |
| CPS | Contingency Preparedness System |
| CRRC | Coastal Response Research Center |
| DWH | Deepwater Horizon |
| EDRC | Estimated Daily Recovery Capacity |
| EPA | Environmental Protection Agency |
| ESA | Environmentally Sensitive Area |
| EVOS | Exxon Valdez Oil Spill |
| FDA | Food and Drug Administration |
| FOSC | Federal On-Scene Coordinator |
| FOSC-R | Federal On-Scene Coordinator's Representative |
| FTX | Field Training Exercise |
| GA | Georgia |
| GFI | Government Furnished Information |
| GOM | Gulf of Mexico |
| GSA | General Services Administration |
| GuLF | Gulf Long-term Follow-up |
| HHE | Health Hazard Evaluation |
| HNS | Hazardous and Noxious Substances |
| ICCOPR | Interagency Coordinating Committee On Oil Pollution Research |
| IMH | Incident Management Handbook |
| IMO | International Maritime Organization |
| IOGP | International Oil and Gas Producers Association |
| ISB | In-Situ Burn |
| ISPR | Incident Specific Preparedness Review |

## LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

| | |
|---|---|
| JIP | Joint Industry Project |
| JITF | Joint Industry Task Force |
| JMTF | Joint Maritime Test Facility |
| LA | Louisiana |
| LLCM | Lessons Learned Collection Manager |
| LSU | Louisiana State University |
| MA | Massachusetts |
| MT | Montana |
| N.H | New Hampshire |
| NCP | National Contingency Plan |
| NEBA | Net Environmental Benefit Analysis |
| NGO | Non-Governmental Organization |
| NIC | National Incident Commander |
| NIEHS | National Institute of Environmental Health Sciences |
| NIH | National Institutes of Health |
| NIOSH | National Institute for Occupational Safety and Health |
| NM | Nautical Mile |
| NOAA | National Oceanic and Atmospheric Administration |
| NRL | Naval Research Laboratory |
| NRT | National Response Team |
| NSFCC | USCG National Strike Force Coordination Center |
| NY | New York |
| OP | Operations |
| OSCA | Oil Spill Commission Action |
| OSHA | Occupational Safety & Health Administration |
| OSPR | Oil Spill Preparedness and Response |
| OSRO | Oil Spill Removal Organization |
| OWM | Oil Weathering Model |
| PA | Pennsylvania |
| PCDD/PCDF | Polychlorinated dibenzo-dioxins/Polychlorinated dibenzo-furans |
| PDF | Portable Document Format |
| PHMSA | Pipeline and Hazardous Materials Safety Administration |
| R&D | Research and Development |
| RCP | Regional Contingency Plan |
| RRI | USCG Response Resource Inventory |
| RRT | Regional Response Team |
| S&T | Science and Technology |
| SAB | Science Advisory Board |
| SIMOPS | Simultaneous Operations |
| SINTEF | Stiftelsen For Industriell Og Teknisk Forskning |
| SMART | Special Monitoring of Applied Response Technologies |

## LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

| | |
|---|---|
| TTX | Tabletop Exercise |
| TX | Texas |
| U.K. | United Kingdom |
| U.S. | United States |
| UAV | Unmanned Aerial Vehicle |
| US | United States |
| USA | United States of America |
| USCG | United States Coast Guard |
| USN | United States Navy |
| VA | Virginia |
| WA | Washington |

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# 1 INTRODUCTION

To ensure that the most effective recommendations were identified and documented, the Gap Analysis utilized a process to gather, analyze, and screen/evaluate a large body of recommendations. Starting with a review of the Government Furnished Information (GFI) and an exhaustive literature search, the team identified an initial set of recommendations, included as Appendix A – Data Collection, that fit the established criteria [post Deepwater Horizon (DWH), and related to In-Situ Burn (ISB) operations or safety issues]. This initial set of recommendations was grouped into affinity areas (Operations, Safety, Research, and Policy) and then further divided into subcategories depending on the focus of the recommendation. The recommendations were then reviewed by subject matter experts to determine which recommendations would have the most significant impacts on the efficacy/efficiency and safety of ISB operations to develop the final set of Gap Analysis recommendations. Following this review, the team contacted the authors/originators of these recommendations to determine whether there had been any progress on those recommendations that was not captured/noted in the source document. This process resulted in a final list of recommendations, which was then grouped into four recommendation areas: Operations, Safety, Research, and Policy. Table 1-1 below summarizes the Gap Analysis recommendation areas. Each specific recommendation area is expanded in the report to identify and discuss specific recommendations in each area.

Table 1-1. List of recommendation areas identified in the gaps analysis.

| Category | Recommendation Areas | Description |
|---|---|---|
| Operations (OP) | Surveillance and Spotting | Communications: Putting appropriate aircraft and trained people in the sky to keep In-Situ Burn (ISB) task groups in the heaviest oil slicks, working with balloons and video/infrared from vessels |
| | Ignition and Fire Boom Equipment | Building upon the experience of prior experimental burns, Exxon Valdez Oil Spill and Deepwater Horizon, we must strive to enhance these tools so that we can expand the window of opportunity (higher wind and sea states) for ISB |
| | Tactics and Support | Working with experienced responders and researchers to validate and improve tactics such as open-apex deflection systems; burning without fire boom (i.e., allowing thermally-induced winds to pull adjacent slicks into an uncontained fire); using unmanned aircraft (and vessels) to release chemical herders to increase oil thickness, and possibly release igniters as well; and developing equipment and procedures for collecting burn residue |
| | Training | Include personnel needed to plan ISB operations and write meaningful contingency plans, responders fully capable of carrying out the tactics and support functions mentioned above, aerial observers to conduct surveillance/spotting missions, and people/equipment to implement safe and effective Vessel-of-Opportunity support. |
| Safety (S) | Responder Safety | Long-term monitoring, health effects studies, best practices, and Training |
| | Public Health | Long-term monitoring, health effects studies, best practices, and Stakeholder outreach and education |
| Research (R) | Tank Tests and Field Trials | The need to conduct tank tests and field trials to validate previous laboratory testing; this includes field trials during spills of opportunity |
| Policy (P) | Simultaneous Operations (SIMOPs) | Deconflicting response options - mechanical, dispersants, and ISB |

## 1.1 Project Description

The scope of this Gap Analysis includes an assessment of after-action reports and progress since the DWH response and development of proposed tasks for future research, which have not already been adequately addressed, to improve ISB offshore performance.

## 1.2 Background

In-Situ Burning (ISB) is a spill response technique that burns the oil in place (in-situ) to eliminate/remove spilled oil from the environment where the oil is spilled. ISB has been explored as a response option since the failed attempt during the Torrey Canyon spill in 1968 off the coast of the United Kingdom.

In the 1990s, mesoscale burn tests at the United States Coast Guard (USCG) Joint Maritime Test Facility (JMTF) in Mobile, AL and at the Ohmsett facility in New Jersey were performed. The first offshore test occurred off Newfoundland, Canada in 1993. By 2003, both the USCG and Environment Canada had produced operation guides and developed the associated equipment and techniques to conduct ISB operations. Although ISB was a viable response option, it was considered an alternative response technique and used infrequently and on a limited scale in the offshore environment. This rationale all changed with the

Deepwater Horizon spill in April, 2010. During the cleanup operations associated with the DWH spill, responders employed the full arsenal of cleanup techniques and ISB was employed purposefully and on a massive scale. During the period when ISB operations were conducted from April 28, 2010 through July 19, 2010, over 375 significant burns were responsible for removing approximately 220,000 to 310,000 barrels of oil from the surface of the water.[2]

Figure 1-1 shows a photo of in-situ burning.

*Photo courtesy of Al Allen*

Figure 1-1. In-situ burning.

The success of ISB operations during the DWH spill response has prompted many in the response community to suggest that ISB operations should be considered a primary response option versus an alternative response option, which is typically how ISB operations are viewed/applied.

## 1.3 Purpose

The purpose of the ISB Gap Analysis is to identify recommendations pertaining to ISB operations and safety that will provide the most significant improvements. For each recommendation identified in the Gap Analysis, the team will provide the following:

- A brief summary of each of the recommendations identified for ISB from the reference documents or general literature search.
- The extent to which the recommendation have been addressed or implemented. To accomplish this, the team developed a scale to rate each recommendation. The following scale will be used throughout the Gap Analysis Report to characterize the status of each recommendation:
    - Limited (L): Interest expressed, with some activity.
    - Moderate (M): Interest, research ongoing.
    - Significant (S): Funding provided, underway.

[2] Allen, Alan; OSPR/Chevron Workshop Presentation, February 15-17, 2011, In-Situ Burn Operations During the Deepwater Horizon Spill.

- How addressing these recommendations will provide more robust and safer ISB operations in response to future spills.
- A description of proposed tasks for future research efforts related to each recommendation.
- Whether any recommendations could utilize the burn testing capability that is available at the Joint Maritime Test Facility (JMTF) facility located in Mobile, Alabama.

## 1.4 Assumptions and Constraints

The following constraints and assumptions were incorporated into the ISB Gap Analysis.

### 1.4.1 Constraints

The following constraints were applied to the ISB Gap Analysis.

- Research Post Deepwater Horizon efforts only.
- Focus on offshore burn operations only, no inshore or land burning recommendations were evaluated.
- Does not include ISB operations in high-latitude environments - unless recommendations can be applied across all ISB operations.
- Primary focus of recommendations are those that will:
  - Improve the efficacy of ISB Operations.
  - Improve the safety of ISB Operations.

### 1.4.2 Assumptions

The following assumption was made as part of the ISB Gap Analysis:

- ISB subject matter expert recommendations are the appropriate method to determine which recommendations have the potential to improve operations/safety of ISB operations.

## 1.5 Documents Reference

Section 7 lists the Government Furnished Information and Appendix B includes the full listing of references used in the development of the gap analysis.

# 2 ISB OPERATIONAL RECOMMENDATIONS

Given the scope and duration of the DWH response operations, there is a large body of lessons learned across a variety of different response techniques. The Gap Analysis reviewed those recommendations and, based on subject matter expert advice, focused the analysis on those recommendations that would have the most significant impact on improving the efficacy/efficiency of offshore ISB operations. One challenge that was identified was that there is a body of recommendations that have been made but are not publically available due to litigation concerns. There is a need to weigh those concerns against the need to make that information available to ensure the latest operational improvements can be implemented. The four recommendation areas that are addressed in the operations section include the following:

- OP1 - Surveillance and Spotting.
- OP2 - Ignition and Fire Boom Equipment.
- OP3 - Tactics and Support.
- OP4 – Training.

Each recommendation area is supported by a number of specific recommendations that are related to the area. In addition to the specific operational recommendations, there are some policy-related recommendations that, if addressed, would improve ISB operations.

## 2.1 Surveillance and Spotting

### 2.1.1 Overview

The surveillance and spotting recommendations are primarily focused on improving the communications aspects of ISB operations to improve coordination between the assets directing and those assets conducting ISB operations. The recommendations also speak to the creation of a program to capture operation lessons learned for additional analysis and application to future events in order to develop a process for continuous improvement. Table 2-1 summarizes the Surveillance and Spotting recommendations.

Table 2-1. Recommendations for OP1 - Surveillance and spotting.

| Area | Recommendation |
|---|---|
| OP1.1 | Improve onboard and air-to-ground radio communications links, Automatic Identification System (AIS), and live video coverage from shore-based and vessel mounted systems. |
| OP1.2 | Develop a program to capture operational information and key lessons learned from the DWH incident and other incidents/tests in order to improve location of targeted oil, keep vessels in heaviest oil concentrations, and to monitor and document volumes of oil burned. |

### 2.1.2 Status

Limited (L): Interest expressed, with some activity
Moderate (M): Interest, research ongoing
Significant (S): Funding provided, underway

**OP1.1**. Current national level requirements do not address operational communications for ISB. To fill this gap, industry and Oil Spill Response Organizations (OSROs) have established their own operational response parameters but they are not consistent across all responders. The Joint Industry Task Force (JITF) has developed a standardized operations manual for ISB, which includes communications, but the National Response Team (NRT) has not adopted it yet. (M)

**OP1.2**. There is no existing ISB specific lessons-learned database in use at this time. There are privately owned reference collections by Allen, SL Dickins, Mabile, Scholz, SL Ross, and others that capture this type of information. The NRT's Selection Guide for Oil Spill Applied Technologies (Selection Guide) provides one resource for documenting the use of ISB during a response but it is just a recommended approach. This guide does not require capture or submission of lessons learned to any type of clearing house. The Coast Guard Incident Management Handbook (IMH) (2014) now designates the Lessons Learned Collection Manager (LLCM) within the Planning Section to manage active and passive collection of responder observations, insights, and lessons for an incident. (L)

### 2.1.3 Impact of Implementation on Operations

Addressing operational communications needs for ISB operations at a national level and developing a standardized approach would apply a certain level of consistency to how ISB operations are conducted and ensure that all ISB operations have effective communications support. The establishment of a specific LLCM position within the Planning Section recognizes the need for this type of activity to take place. If the position is staffed, provided the lessons learned are captured and documented in the Contingency Preparedness System (CPS) (the Coast Guard's tool for capturing and tracking lessons learned), this could be a positive development.

### 2.1.4 Summary Table

Table 2-2 below summarizes the Surveillance and Spotting recommendations. The table includes a specific recommendation for future research in the area of developing tools or guidance documents [e.g., ISB calculator such as the National Oceanic and Atmospheric Administration's (NOAA) Dispersant Mission Planner], which would create a guidance document on required operational parameters for on-water ISB, including communication requirements. Additionally, the table includes a recommendation to create a central clearing house for capturing and documenting operational information and key lessons learned for future spills; the database should be searchable and publicly accessible.

Table 2-2. ISB Gap Analysis and Recommendations for OP1 - Surveillance and spotting (Communications).

**Applicability:**

- o Aerial Observers (Surveillance and spotting personnel)
- o Controlled ISB Division/Group/Supervisors
- o ISB Operations personnel (includes vessel operators and ISB platform wildlife monitors)[3]

**Recommendation(s):**

**OP1.1** Communications: Improved onboard and air-to-ground radio communications links, AIS, and live video coverage from shore-based and vessel mounted systems are needed.

**OP1.2** Develop a program to capture operational information and key lessons learned from the Deepwater Horizon incident and other tests and incidents involving ISB.

**Extent which the recommendation has been addressed or implemented:**

**OP1.1:**

- Current requirements do not address operational communications for ISB
- Industry and OSROs have established their own operational response parameters
- Additional work has been done on ISB operations; JITF industry has developed a standardized operations manual for ISB, which includes communications; this document has not been adopted by the NRT.

**OP1.2:**

- No existing database is known at this time. Privately owned reference collections by Allen, SL Dickins, Mabile, Scholz, SL Ross and others exist.
- The NRT's Selection Guide for Oil Spill Applied Technologies (Selection Guide) provides one resource for documenting the use of ISB during a response.
- The USCG IMH (2014) now designates the Lessons Learned Collection Manager (LLCM) within the Planning Section to manage active and passive collection of responder observations, insights, and lessons for an incident.

**Impact of Recommendation:**

- o Improved operational efficiency
- o Incident response documentation and safety

**Description of Proposed Tasks for Recommendation for Future Research Efforts:**

**OP1.1**

- o Develop tools or guidance documents (e.g., ISB calculator such as NOAA's Dispersant Mission Planner) for 33 CFR Facility Planning Requirements.
- o Create a guidance document on required operational parameters for on-water ISB that addresses the entire operation and includes the communications aspects.

**OP1.2**

- o Update and expand the Selection Guide documentation requirements and updates.
- o Create a central clearing house for capturing and documenting operational information and key lessons learned for future spills. The database should be searchable and publicly accessible.

**Potential Policy Needs:**

- o NRT needs to develop guidance document for Area and Regional Planning and adoption for pre-authorization.
- o Propose new set of regulations similar to the USCG Planning Rules for Dispersants for Offshore In Situ Burning required in all areas where preauthorization has been established under the Regional Contingency Plan (RCP) or Area Contingency Plan (ACP) under 40 CFR 300.
- o Use established guidance protocols used by the NRT for promulgation within the National Contingency Plan (NCP).

[3] Effects monitoring, NRDA sampling, etc. are not part of this operation communications analysis.

Table 2-2. ISB Gap Analysis and Recommendations for OP1 - Surveillance and spotting (Communications) (Continued).

| List of Key References Used: |
| --- |
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## 2.2 Ignition and Fire Boom Equipment

### 2.2.1 Overview

The ignition and fire boom equipment recommendations focus on making improvements to the current fire booms to determine whether they can be improved to function in higher sea states and at higher towing speeds; they also focus on the need for additional research and testing on the igniters to determine whether the current types of igniters can be improved. The current hand-held igniters are effective and have worked well during ISB operations but there is still a need to look at other alternatives that do not involve deployment of a hand held igniter. Additionally, there are recommendations to develop a capability for the Stiftelsen for Industriell og Teknisk Forskning (SINTEF) Oil Weathering Model (OWM), and other models to predict windows of opportunity for ISB operations based on equipment and environmental condition inputs. Table 2-3 summarizes the ignition and fire boom equipment recommendations.

Table 2-3. Recommendations for OP2 - Ignition and fire boom equipment.

| Area | Recommendations |
|---|---|
| OP2.1 | Fire Boom: Evaluate the performance of various fire boom designs and evaluate ways to improve the technologies for a water-cooled boom; conduct research and development into a fire boom that is more efficient in higher sea states and at faster advancing speeds; develop enhanced designs for containment and burning oil that include better, longer service-life fire containment booms. |
| OP2.2 | Igniters: Conduct mesoscale and full-scale field tests to enhance surface and aerial ignition techniques and equipment. |
| OP2.3 | Based on the data from laboratory burnability testing on different oil types and weathering degrees, implement the ability to predict the window of opportunity for ISB in SINTEF and other oil weathering models (OWM). |
| OP2.4 | Use the results of OP2.2 to determine ways to further enhance ignition under a broad range of environmental conditions, including strong winds, waves, rain, ice & snow, etc.; and, maybe even for the ignition of tough-to-ignite oils such as bunkers, emulsions, etc. |

### 2.2.2 Status

Limited (L): Interest expressed, with some activity
Moderate (M): Interest, research ongoing
Significant (S): Funding provided, underway

**OP2.1**. Fire boom advances (OP2.4.1, OP2.4.2, and OP2.4.3): Research and Development (R&D) and fire boom testing continues in various sectors. (M)

- Mabile (2010) provided evaluation of fire boom for BP post Deepwater Horizon.
- American Society for Testing and Materials (ASTM revised F20.15 In-situ burn standard F1990-07 - Fire-resistant boom in 2013.
- In September 2014, Elastec/American Marine hosted the International Oil Spill Response Workshop to share lessons learned from some of the most challenging oil spill response operations in the world, including in situ burning.

**OP2.2**. Igniter advances include the ASTM revision to F20.15 In-situ burn standard F2152-07 - Ignition Devices in 2013. (M)

**OP2.3**. Limited modeling being done by SINTEF and others; status in the U.S. not determined and should be researched. (M)

**OP2.4**. No significant research identified in the area of determining the accelerant payload under different conditions. (L)

### 2.2.3 Impact of Implementation on Operations

The impacts of these recommendations include the ability to conduct longer burns so the maintenance and upkeep of burn booms during a response can be minimized, which result in better recovery and removal efforts by the response organization. Enhances in fire booms and igniters for ISB would improve response efficiency, burn ignition, and responder safety. Additionally, improvements in ISB equipment could expand response windows of opportunity and enhance effectiveness. Research and development into ISB equipment would also provide scientific data to replace anecdotal information regarding ISB equipment performance. Improved controlled ISB models would make them far more effective as response and planning tools.

### 2.2.4 Summary Table

Table 2-4 below summarizes the Ignition and Fire Boom Equipment recommendations. The table includes specific recommendations for future research at the JMTF to improve recovery technology for ISB operation residue. Additionally, ISB test plans should be developed and approved for use during spills of opportunity to take advantage of situations that enable testing in a real world situation. There should also be additional R&D efforts to improve ISB equipment in order to expand the ISB window of opportunity (e.g., use the technique in higher wind and sea states).

Table 2-4. ISB Gap Analysis and Recommendations for OP2 - Ignition and fire boom equipment.

| **Applicability:** |
|---|
| o Operations-level: Plan writers, ISB operators (those that carry out the tactics), aerial observers, safety personnel (operations / public health), wildlife monitors |
| **Recommendation(s):** |
| **OP2.1 Fire Boom:**<br>**OP2.1.1** Evaluate the performance of various fire boom designs. Look to improve technologies for water-cooled and reusable boom types<br>**OP2.1.2** Research and development into fire boom that is more efficient in higher sea states and faster advancing speeds<br>**OP2.1.3** Develop enhanced designs for containment and burning oil that include better, longer service-life fire containment booms<br>**OP2.2 Igniters:**<br>**OP2.5.1** Laboratory and field-testing develop new igniters also including the use of surfactants for enhancing breaking water in oil emulsions<br>**OP2.3** Based on the data from laboratory burnability testing on different oil types and weathering degrees, implement the ability to predict the window of opportunity for in-situ burning in SINTEF OWM and other oil weathering models<br>**OP2.4** Use the results of OP2.2 to determine ways to further enhance ignition under a broad range of environmental conditions, including strong winds, waves, rain, ice, snow, etc.; and, maybe even for the ignition of tough-to-ignite oils such as bunkers, emulsions, etc. |
| **Extent which the recommendation has been addressed or implemented:** |
| **OP2.1** R&D and fire boom testing continues in various sectors<br>• Mabile (2010) provided evaluation of fire boom for BP post Deepwater Horizon<br>• ASTM revised F20.15 In-situ burn standard F1990-07 - Fire-resistant boom in 2013<br>• In September 2014, **Elastec/ American Marine hosted the International Oil Spill Response Workshop to** share lessons learned from some of the most challenging oil spill response operations in the world, including in situ burning<br>**OP2.2** Igniter advances<br>• Research continues in various sectors<br>• ASTM revised F20.15 In-situ burn standard F2152-07 - Ignition Devices in 2013<br>**OP2.3** Some modeling being done by SINTEF and others; status in the U.S. not determined.<br>**OP2.4** Not determined |
| **Impact of Recommendation:** |
| o Better recovery and removal efforts by the response organization<br>o Enhances in situ burning<br>o Would provide scientific data to replace anecdotal information from responders |

Table 2-4. ISB Gap Analysis and Recommendations for OP2 - Ignition and fire boom equipment (Continued).

| Impact of Recommendation (Continued): |
|---|
| o More effective response<br>o Longer burns can be attempted and maintenance and upkeep of burn boom during a response should be minimized<br>o Improve response efficiency, burn ignition, and responder safety<br>o Expand response window of opportunity and enhance effectiveness<br>o Improved controlled ISB models making them far more effective as response tool |
| **Description of Proposed Tasks for Recommendation for Future Research Efforts:** |
| **All OP2 Recommendations**: Additional testing of current and R&D efforts to improve recovery technology for in situ burn operations should be conducted at JMTF<br>**All OP2 Recommendations**: Spills of opportunity should be used to test response equipment (*See also R1*)<br>**OP2.4.2** Expand the ISB window of opportunity (e.g., higher wind and sea states)<br>**Potential Policy Needs**: (*See also R1*)<br>o Develop spills of opportunity guidance for ISB<br>o Coordinate with agencies and the public to develop and promulgate policy on when full-scale at-sea trials can be conducted with oil<br>o OSRO authorization for ISB; USCG NSFCC RRI database should be modified to address ISB requirements by certified OSROs |
| **List of Key References Used:** |
| Allen, A.A. 2011. Presentation: In-situ Burn Operations during the Deepwater Horizon Oil Spill. OSPR / Chevron Oil Spill Response Technology Workshop: Chevron Park – San Ramon, California, February 15-17, 2011. 33 slides.<br>ASTM Subcommittee F20.15 on In-Situ Burning (F1788-14; F1990-07(2013); F2152-07(2013), WK37324). Available from: http://www.astm.org/COMMIT/SUBCOMMIT/F2015.htm.<br>Brandvik, P.J., K.R. Sorheim, I. Singsaas, and M. Reed. 2006. Oil in Ice Report No. 1: Short State-of-the-Art Report on Oil Spills in Ice-Infested Waters. Final. SINTEF Report A06148 Open. SINTEF Materials and Chemistry, Marine Environmental Technology. 63 p.<br>Buist, McCourt, Potter, Ross & Trudel. 1999. In Situ Burning. Pure Applied Chemistry, Vol. 71.<br>Bureau of Safety and Environmental Enforcement (BSEE). 2012. BAA Proposed Research on Oil Spill Response Operations.<br>Goodman, B.T., R.A. Davidson, E.S. Siervert, and L. Wood. 2014. Initiating In Situ Burning of Difficult-to-Ignite Oil Spills via an Aircraft-Deployable Igniter System. In: *Proceedings of the 2014 International Oil Spill Conference*, Savannah, GA. USA. pp. 1821-1833.<br>Interagency Coordinating Committee on Oil Pollution Research (ICCOPR). 2010. Meeting Notes for the Public Meeting held September 16, 2010 in Washington, D.C. 29 p.<br>Joint Industry Task Force Progress Report on Industry Recommendations to Improve Oil Spill Preparedness and Response. November 2011.<br>Mabile, N.J. 2010. Fire Boom Performance Evaluation: Controlled Burning During the Deepwater Horizon Spill. Report to BP America. Houston, TX, USA.<br>National Commission on the BP Deepwater Horizon Oil spill and Offshore Drilling. 2011. Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling. Report to the President. 398 p.<br>SINTEF (2006) Oil in Ice Report No. 1.<br>U.S. Coast Guard. 2011. BP Deepwater Horizon Oil Spill: Incident Specific Preparedness Review (ISPR) and Memorandum. ADM R.J. Papp, Jr. Prepared for Department of Homeland Security.<br>Zhang, Nedwed, Tidwell, Urbanski, Cooper, Buist, and Belore (2014) One-Step Offshore Oil Skim And Burn System For Use With Vessels Of Opportunity. |

## 2.3 Tactics and Support

### 2.3.1 Overview

The tactics and support recommendations address the development and documentation (via updated operations manuals) of ISB tactics and procedures. A key recommendation in this area is the use of open apex booming systems. These systems are typically used to increase encounter rates for skimming operations. The Bureau of Safety and Environmental Enforcement (BSEE) report on Estimated Daily Recovery Capacity (EDRC) noted the following about this technique, "Of all the tools and techniques, there is one that stands out as a major enhancement for improving the amount of oil that any recovery system might access. It is the use of an "open-apex" U-boom configuration that can be towed with a wide (500- to 1,000-foot) leading swath. The swaths and speeds of these systems depend on the type of boom used, the horsepower of the boom-tending boats, and the ambient sea conditions. Under the right conditions, a large oil deflection system can be used to concentrate oil through its downstream "open apex, typically 25 to 50 feet wide. A 500-foot leading swath configuration of this type with a 25-foot open apex could increase the average oil layer thickness entering the system by a factor of twenty at its exit."[4] (See Figure 2-1).

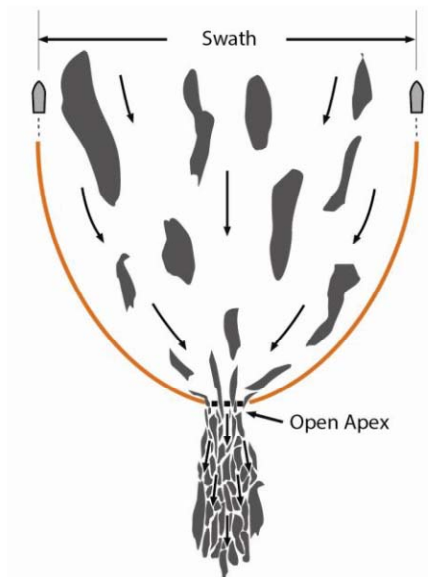


Figure 2-1. Open apex booming.

The recommendations in this section also address the need to look for alternative methods of ignition during ISB operations. All of the burns conducted during DWH were ignited with hand-held igniters (See Figure 2-2). While effective, this tactic also places response personnel in close proximity to the burn area when deploying the igniter. The use of unmanned aircraft to deploy igniters is one technique that could potentially increase operational effectiveness when lighting multiple burns over large distances.

Additionally, this section looks at collecting ISB residues following a burn and methods for increasing encounter rates during a burn to improve the efficacy of ISB operations, which require some tactical testing/research and the implementation of new/updated policy.

[4] Allen, A, Dale, D, Galt, J and Murphy, J. 2010. Estimated Daily Recovery Capacity (EDRC) Final Project Report. Developed for the U. S. Department of the Interior, Bureau of Safety and Environmental Enforcement (BSEE), Under GSA Contract GS-00F-0002W, BSEE Order # E12-PD-00012. 154 p.

*Photo courtesy of Al Allen*

Figure 2-2. Deployment of handheld igniter.

Table 2-5 summarizes the recommendations for OP3 - Tactics and Support.

Table 2-5. Recommendations for OP3 - Tactics and support.

| Area | Recommendations |
|---|---|
| OP3.1 | Improve and validate use of open-apex deflection systems. |
| OP3.2 | Investigate using unmanned aircraft and vessels to ignite slicks. |
| OP3.3 | Develop equipment and procedures for collecting controlled ISB residue. |
| OP3.4 | Develop methods to increase the encounter rate for in-situ burning operations by increasing amount/thickness of oil on the surface.<br><br>**OP3.4.1**. Controlled burning outside of the fire boom can provide certain advantages and should be studied and field tested by industry and government.<br>**OP3.4.2**. Enhance the use of herding agents and demulsifiers to augment or be alternatives to fire boom.<br>**OP3.4.3.** Investigate using unmanned aircraft and vessels to release herding agents.<br>**OP3.4.4**. Identify herding agents that perform well in warm water conditions.<br>**OP3.4.5**. Define the sea condition parameters that produce most effective use of herders.<br>**OP3.4.6**. Complete appropriate toxicity testing of herding agents for inclusion on Environmental Protection Agency's (EPA) NCP Product Schedule. |
| OP3.5 | Need a method of quantifying effectiveness to compare methods of ignition and burning. |

### 2.3.2 Status

Limited (L): Interest expressed, with some activity
Moderate (M): Interest, research ongoing
Significant (S): Funding provided, underway

**OP3.1**. Shell worked on open-apex systems for their Arctic Environment Spill Response Program via the JITF mechanical recovery workgroup. Still need to establish operational guidelines and determine whether the open-apex booming technique is able to increase the efficacy of, and expand the windows of opportunity for, ISB operations. Of particular interest is looking at the potential to burn the oil as it is released from the

open apex where the fire is sustained by the radial inward flow of air to replace the thermally induced rise of air over the fire, and the resulting "feed" and "concentration" of oil from surrounding slicks. This phenomenon was seen in several burns during DWH and enables burning without the need for fire boom to contain the burning oil. (L)

**OP3.2**. The use of unmanned aircraft and vessels varies based on location of spill. The authorization for Unmanned Aerial Vehicles (UAVs) is more prevalent, but is region dependent; there are no solid operational guidelines established. (L)

**OP3.3**. The related research on ISB residues has looked at the toxicity and behavior of residues as they cool following the burn. Depending on a wide range of factors, including the type and thickness of the oil during the burn, certain residues will sink as they cool and could impact benthic organisms.(L)

**OP3.4**. Some lab testing has been conducted by SLRoss, Joint Industry Project (JIP), and SINTEF on herders. There is a clear need for field-testing to determine how herders can be used to support ISB operations on larger scales.  Beyond that limited research and testing, none of the recommendations have been implemented. (L)

**OP3.5.** The ASTM F20.15 committee is currently working on developing (WK37324) the new Standard Guide for Evaluation of In-Situ Burning Effectiveness. (M)

### 2.3.3 Impact of Implementation on Operations

Research into techniques like open apex booming will increase the diversity of tactics and provide more advanced equipment related to controlled ISB operations and will improve ISB operations efficacy/efficiency. Research into alternate ignition techniques will improve response efficiency, burn ignition, and responder safety via the use of unmanned aircraft and vessels. Developing techniques for the removal of ISB residues will provide greater environmental protection following controlled ISB operations by removing burn residue and could improve stakeholder perceptions about this technique. Researching herder use has the potential to expand where ISB can take place by taking advantage of the difference between sea-state failure for fire-boom and sea-state failure for herders. Effective tactics that employ herders in conjunction with, or in place of fire boom, could decrease equipment requirements.

Summary Table 2-6 below summarizes the Tactics and Support recommendations. The table includes specific recommendations for future research into the following tactics/techniques:

- Open-apex deflection systems.
- Deployment of unmanned aircraft and vessels for burn ignition and herder application.
- Equipment and procedures to recover burn residue.
- Appropriate herder/demulsifier deployment scenarios/conditions, sea state conditions, water temperature.

In addition to the research on the specific tactics/techniques, there is a need for the development of operational guidelines to ensure that the execution of the tactics is consistent, given the regional and environmental variations that might be encountered.  The development of the ASTM standard will provide a method to calculate and document the amount of oil burned which can be used to compare herder/emulsifier scenarios and provide information for oil budget calculations during a spill.

Table 2-6. ISB Gap Analysis and Recommendations for OP3 - Tactics and support.

**Applicability:**

- o Plan-writers, ISB Division/Group Supervisors, and controlled ISB operators (those that carry out the tactics)

**Recommendation(s):**

**OP3.1** Improve and validate use of open-apex deflection systems

**OP3.2** Investigate using unmanned aircraft and vessels to ignite slicks

**OP3.3** Develop equipment and procedures for collecting controlled ISB residue

**OP3.4** Develop methods to increase the encounter rate for in-situ burning operations by increasing amount/thickness of oil on the surface

- **OP3.4.1** Controlled burning outside of the fire boom can provide certain advantages and should be studied and field tested by industry and government
- **OP3.4.2** Enhance the use of herding agents and demulsifiers to augment or be alternatives to fire booms
- **OP3.4.3** Investigate using unmanned aircraft and vessels to release herding agents
- **OP3.4.4** Identify herding agents that perform well in warm water conditions
- **OP3.4.5** Define the sea condition parameters that produce most effective use of herders
- **OP3.4.6** Complete appropriate toxicity testing for inclusion on EPA's NCP Product Schedule

**OP3.5** Need better means of quantifying effectiveness of a response

**Extent which the Recommendation has been Addressed or Implemented:**

**OP3.1** Shell worked on open-apex booming systems for Arctic environment spill response program; JITF mechanical recovery workgroup

**OP3.2** Use of unmanned aircraft and vessels varies based on location of spill. Authorization for UAVs more prevalent, but is region dependent

**OP3.3** Related research: Shigenaka (2014); BSEE Project 1010 – Burn residue DWH; Potter & Buist (2011) BSEE Project 647 – Recovery Burn residue; Fritt-Rasmussen et al. 2013. Comp ISB residue

**OP3.4** Some lab work conducted by SLRoss, JIP, and SINTEF on herders

- **OP3.4.4** Some labs field tested herders in warm water conditions

**OP3.5** ASTM is developing a guide**.**

**Impact of Recommendation:**

- o Improved response efficiency, burn ignition, and responder safety via unmanned aircraft and vessels
- o Greater environmental protection post controlled ISB by removing burn residue
- o Improved operational ISB operations efficacy/efficiency

- Used to augment or replace need for boom
- Increased diversity of tactics and more advanced equipment related to controlled ISB operations
- Increase surface oil thickness
- Expand where ISB can take place by taking advantage of difference between sea-state failure for fire-boom and sea-state failure for herders

Provide a standard which allows ISB workers to accurately and consistently document and calculate the amount of oil burned within the area of a burn; this calculation becomes very important for estimating an oil budget and litigation afterwards

**Potential Policy Needs:**

- o Area Committees and Regional Response Teams in the U.S. have to establish herder agent use guidance for their Federal On-Scene Coordinator (FOSC); region dependent
- o Additional R&D/testing needed for:

Table 2-6. ISB Gap Analysis and Recommendations for OP3 - Tactics and support (Continued).

| **Description of Proposed Tasks for Recommendation for Future Research Efforts: (Continued)** |
|---|
| **OP3.1** Open-apex deflection systems<br>**OP3.2 and OP3.4,3** Appropriate deployment of unmanned aircraft and vessels for burn ignition, and herder application<br>**OP3.3** Equipment and procedures to recover burn residue<br>o **OP3.4** Appropriate herder/demulsifier deployment scenarios/conditions, sea state conditions, water temperatureCreate a guidance document on required operational parameters for:<br>**OP3.1** Open-apex deflection systems<br>**OP3.2** Unmanned aircraft and vessel operations for burn ignition and herder application<br>**OP3.3** Recovering burn residue<br>**OP3.4** Herder use during on water in-situ burning (how you do ISB with herders)<br>**OP3.4** Toxicity testing for NCP Product Schedule for herders being tested; add validated tactics to selection guide<br>**OP3.1, OP3.2, OP3.3, OP3.4** Recommend changes to ASTM F20.15 Subcommittee to address changes<br>**Potential Policy Needs:**<br>**OP3.4** NRT to develop guidance document for Area and Regional Planning and adoption for pre-authorization (to include all validated tactics to include herder use parameters)<br>**OP3.5** Evaluate ASTM standard in meso-scale tank tests |
| **List of Key References Used:** |
| Allen, A.A. 2011. Presentation: In-situ Burn Operations during the Deepwater Horizon Oil Spill. OSPR / Chevron Oil Spill Response Technology Workshop: Chevron Park – San Ramon, California, February 15-17, 2011. 33 slides.<br>Allen, A.A., N.J. Mabile, D. Jaeger, and D. Costanzo. 2011. The Use of Controlled Burning during the Gulf of Mexico Deepwater Horizon MC-252 Oil Spill Response. 2011 International Oil Spill Conference.<br>Allen, A, Dale, D, Galt, J and Murphy, J. 2010. Estimated Daily Recovery Capacity (EDRC) Final Project Report. Developed for the U. S. Department of the Interior, Bureau of Safety and Environmental Enforcement (BSEE), Under GSA Contract GS-00F-0002W, BSEE Order # E12-PD-00012. 154 p.<br>ASTM Subcommittee F20.15 on In-Situ Burning (F1788-14; WK37324; others as applicable). Available from: http://www.astm.org/COMMIT/SUBCOMMIT/F2015.htm.<br>Brandvik, P.J., K.R. Sorheim, I. Singsaas, and M. Reed. 2006. Oil in Ice Report No. 1: Short State-of-the-Art Report on Oil Spills in Ice-Infested Waters. Final. SINTEF Report A06148 Open. SINTEF Materials and Chemistry, Marine Environmental Technology. 63 p.<br>Buist, I. 2010. Field Testing of USN Oil Herding Agent on Heidrun Crude in Loose Drift Ice. SINTEF JIP Report No. 6, Trondheim, Norway, 53 p., March, 2010.<br>Buist, I. and T. Nedwed. 2011. Using Herders for Rapid In Situ Burning of Oil Spills on Open Water. In: Proceedings of the 2011 International Oil Spill Conference, Portland, OR, USA. 7 p.<br>Buist, McCourt, Potter, Ross & Trudel. 1999. In Situ Burning. Pure Applied Chemistry, Vol. 71.<br>Bureau of Safety and Environmental Enforcement (BSEE). 2012. BAA Proposed Research on Oil Spill Response Operations.<br>Interagency Coordinating Committee on Oil Pollution Research (ICCOPR). 2010. Meeting Notes for the Public Meeting held September 16, 2010 in Washington, D.C. 29 p.<br>Interagency Coordinating Committee on Oil Pollution Research (ICCOPR). 2010. Meeting Notes for the Public Meeting held November 17, 2010 in New Orleans, Louisiana. 53 p.<br>National Response Team (NRT). 2010. Selection Guide for Oil Spill Applied Technologies: Electronic and PDF versions. Available from: www.sg.nrt.org.<br>SINTEF (2006) Oil in Ice Report No. 1<br>SL Ross. 2012. Research on Using Oil Herding Agents for Rapid Response In Situ Burning of Oil Slicks on Open Water.<br>U.S. Coast Guard (USCG). 2014. Incident Management Handbook. U.S. Coast Guard COMDTPUB P3120.17B. May 2014. 382 p.<br>U.S. Coast Guard. 2011. BP Deepwater Horizon Oil Spill: Incident Specific Preparedness Review (ISPR) and Memorandum. ADM R.J. Papp, Jr. Prepared for Department of Homeland Security. |

## 2.4 Training

### 2.4.1 Overview

The training recommendations focus on two specific areas: the development of an ISB lessons-learned body of knowledge (BOK) to support the capture, analysis, and sharing of ISB lessons learned; and the development of a formal training program for personnel engaged in ISB operations. Table 2-7 summarizes the training recommendations.

Table 2-7. Recommendations for OP4 – Training.

| OP4 | Training |
|---|---|
| OP4.1 | Develop a program to capture operational information and key lessons learned from any historic spill, including the Deepwater Horizon incident, and all other tests and incidents involving in-situ burn.<br>**OP4.1.1**. Recommend that trustee agencies work together to provide a central location to archive reports, data, and photographs for each spill and subsequent monitoring activities.<br>**OP4.1.2**. Agencies or their delegates should evaluate and synthesize this information on a yearly basis and provide cumulative reports describing current knowledge of oil spill cleanup technology, tactics and techniques. |
| OP4.2 | Use the spill response Body of Knowledge to develop training requirements and a training program for in-situ burn responders and supervisors.<br>**OP4.2.1**. Development of standard training course material.<br>**OP4.2.2**. Training, field exercises, and field experience are necessary to maintain proficiency of spotters, logistical and operational coordinators, pilots and Special Monitoring of Applied Response Technologies (SMART) teams.<br>**OP4.2.3**. Require routine practice in the preparation and approval process as part of drills and exercises to ensure this aspect gets exercised and can benefit from lessons-learned.<br>**OP4.2.4**. Organize advanced personnel training opportunities for in-situ burn operations.<br>**OP4.2.5**. Use spills of opportunity for in-situ burn training. (See also R1) |

### 2.4.2 Status

Limited (L): Interest expressed, with some activity
Moderate (M): Interest, research ongoing
Significant (S): Funding provided, underway

**OP4.1**. There is no known publically shared database available that is detailed enough to document these types of information needs.(L)

**OP4.2**. There is no known on-the-water training for ISB currently available in the U.S. or internationally.(L)

### 2.4.3 Impact of Implementation on Operations

Archiving the information and establishing ownership of the archive will ensure that all controlled ISB related documents, research papers, lessons learned, and any other pertinent information is collected and stored in a central repository. In order to be effective, there will have to be a process to review, analyze, and synthesize the information for broad public consumption and to assist with development of learning objectives for a standardized training program.

Creating the training program will result in a nationally recognized and standardized training document that can be used to develop training programs within the industry/response community (including OSROs); provide training curriculum for FOSC, ISB Division/Group Supervisor personnel, and industry consistent across all sectors; and provide training and exercise scenarios for incorporation into ISB related exercises.

### 2.4.4 Summary Table

Table 2-9 below summarizes the Training recommendations. The table includes specific recommendations for future research into the following training areas:

- Recommend that the NRT establish and house a publically available data library of all ISB (and dispersant, etc.) references. Further recommend that this data library is routinely reviewed and a consistent process for reporting on key concepts and advances in controlled ISB Operations is developed.
- Create training documents (Operations and Awareness levels) that reinforce terminal learning objectives related to operational parameters for on-water in-situ burning (how to do ISB).
- Create nationally consistent, hands-on training courses:
  - Operations Level ISB that tests trainee's knowledge of how to conduct the full suite of ISB operations. Operations Level training course to be conducted at the JMTF.
  - Awareness-level operational ISB that provides guidance on notifying authorities, taking action to initiate ISB authorization, knowledge of ISB logistics and operational requirements, and command authority. Awareness level training to be sponsored at Regional Response Team (RRT) meetings and Area Committee meetings.
  - Track individuals (subject matter experts) who have undergone the training.
- Develop a National ISB Operator Certification Program.
- Create a nationally consistent, table-top training course that is exportable and/or part of other oil spill exercise programs.

Table 2-8. ISB Gap Analysis and Recommendations for OP4 – Training.

| **Applicability** | |
|---|---|
| | o **Operations Level**: Plan writers, in-situ burn operators (those that carry out the tactics), aerial observers, (safety personnel (operations / public health), wildlife monitors<br>o **Awareness Level**: FOSC-Representative, FOSC, RRTs, and Area Committees, Incident Command |
| **Recommendation(s):** | |
| **OP4.1** | Develop a program to capture operational information and key lessons learned from any historic spill, including the Deepwater Horizon incident and all other tests and incidents involving in-situ burn.<br>**OP4.1.1** Recommend that trustee agencies work together to provide a central location where reports, data, and photographs would be archived for each spill and subsequent monitoring activities.<br>**OP4.1.2** Agencies or their delegates should evaluate and synthesize this information on a yearly basis and provide cumulative reports describing current knowledge of oil spill cleanup technology. |
| **OP4.2** | Using this information, develop training requirements and a training program for in-situ burn responders and supervisors.<br>**OP4.2.1** Development of standard training course material.<br>**OP4.2.2** Training, field exercises, and field experience are necessary to maintain proficiency of spotters, logistical and operational coordinators, pilots, and SMART teams.<br>**OP4.2.3** Requires routine practice in the preparation and approval process as part of drills and exercise.<br>**OP4.2.4** Advanced personnel training opportunities for in-situ burn operations should be organized. |
| **OP4.2.5** | Use spills of opportunity for in-situ burn training. (*See also R1*) |
| **Extent which the Recommendation has been Addressed or Implemented:** | |
| **OP4.1** | Unknown; no known publically shared database is available that is detailed enough to document these information needs |
| **OP4.2** | No known on-water training for ISB is currently available in the U.S. or internationally |
| **Impact of Recommendation:** | |
| **OP4.1** | All controlled ISB related documents, research papers, lessons learned and any other pertinent information is collected, stored, reviewed, analyzed, and synthesized for broad public consumption and to assist with development of learning objectives for a standardized training program. |
| **OP4.2** | Create a nationally recognized and standardized training document that can be used to develop training programs within industry/response community (including OSROs). |
| **OP4.2** | Provide training curriculum for FOSC, ISB Division/Group Supervisor personnel, and industry consistent across all sectors. |
| **OP4.2** | Provide training and exercise scenarios for incorporation into Tabletop Exercises (TTX) and Field Training Exercises (FTX) or as a standalone exercise. |
| **Description of proposed tasks for Recommendation for Future Research Efforts:** | |
| **OP4.1** | Recommend that the NRT establish and house a publically available data library of all ISB (and dispersant, etc.) references. Further recommend that this data library is routinely reviewed and a consistent process for reporting on key concepts and advances in controlled ISB Operations is developed.<br>o Funding will be required to initiate and maintain this effort of operational information and key lessons learned from the Deepwater Horizon incident and other tests and incidents involving ISB.<br>o Recommend that trustee agencies work together to provide a central location where reports, data, and photographs would be archived for each spill and subsequent monitoring activities; evaluate and synthesize this information on a yearly basis; and provide cumulative reports describing current knowledge of oil spill cleanup technology. |

Table 2-8. ISB Gap Analysis and Recommendations for OP4 – Training (Continued).

| Description of proposed tasks for Recommendation for Future Research Efforts (Continued): |
|---|
| **OP4.2.1** Create training documents (Operations and Awareness levels) that reinforce terminal learning objectives related to operational parameters for on-water in-situ burning (how to do ISB).<br>**OP4.2.4** Create nationally consistent, hands-on training courses for:<br>• Operations-Level ISB training that tests trainee's ability to initiate ISB activities based on Defensive response; taking action to contain the release and ensure proper thickness; and knowledge of how to conduct a full suite of ISB operations, technical assistance to incident command sea-state, and other conditional parameters<br>• Operations Level training course to be conducted at JMTF<br>• Awareness-level operational ISB that provides guidance on notifying authorities, taking action to initiate ISB authorization, knowledge of ISB logistics and operational requirements, command authority<br>• Sponsor Awareness level training to RRTs and Area Committees<br>• National ISB Operator (and Awareness-level?) Certification Program<br>• Tracking of individuals (subject matter experts) who have undergone the training<br>**OP4.2.4** Create a nationally consistent, table-top training course that is exportable and/or part of other oil spill TTX/Full scale exercises.<br>**Potential Policy Needs:**<br>**OP4.2**<br>o Revise Preparedness for Response Exercise Program (PREP) requirements to address ISB training; update to address ISB.<br>o Include as a topic in the USCG Crisis Management Course for FOSCs. |
| **List of Key References Used:** |
| Allen, Mabile, Jaeger, and Costanzo. 2011. IOSC ISB paper.<br>U.S. Arctic Research Commission. 2004.<br>BP America Paper (2006) In-Situ Burning in Inland Regions.<br>Joint Industry Task Force Progress Report on Industry Recommendations to Improve Oil Spill Preparedness and Response. 2012. Second Progress Report on Industry Recommendations to Improve Oil Spill Preparedness and Response. November 16, 2012. 27 p.<br>Joint Industry Task Force Progress Report on Industry Recommendations to Improve Oil Spill Preparedness and Response. November 2011.<br>Mabile (2012) The Coming of Age of Controlled In-Situ Burning: Transition from Alternative Technology to A Conventional Offshore Spill Response Option.<br>Marine Mammal Commission. 2010. Letter re: Comments for the Interagency Coordinating Committee on Priorities for Oil Pollution Research. 9 September, 2010.<br>Mendelssohn, Hester, and Pahl (1996) LSU Tech Report Environmental Effects And Effectiveness Of In Situ Burning In Wetlands: Considerations For Oil Spill Cleanup.<br>National Response Team (NRT). 2010. Selection Guide for Oil Spill Applied Technologies: Electronic and PDF versions. Available from: www.sg.nrt.org.<br>U.S. Coast Guard. 2011. BP Deepwater Horizon Oil Spill: Incident Specific Preparedness Review (ISPR) and Memorandum. ADM R.J. Papp, Jr. Prepared for Department of Homeland Security.<br>U.S. Coast Guard, Environmental Protection Agency (EPA), Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA), and Department of the Interior's Bureau of Safety and Environmental Enforcement (BSEE). 2014. DRAFT: National Preparedness for Response Exercise Program. January 2014 version. 110 p. |

# 3 ISB SAFETY RECOMMENDATION AREAS

Human health and safety of the responders and the public is paramount in an oil spill response. During the Deepwater Horizon response, more than 40,000 response workers and volunteers participated in the response cleanup across the Gulf Region. BP, working under the direction of the U.S. Coast Guard, coordinated with the National Institute for Occupational Safety and Health, the U.S. Occupational Safety and Health Administration, and other organizations to help manage potential health risks posed in the response. Immediate measures included the identification of potential hazards to the responders and strategies to communicate, manage, and reduce potential risks that might be present. These risks included worker and public health and safety issues associated to large-scale operational measures including in-situ burning.

The DWH response presented unique challenges in protecting response workers spread across the Gulf region, who performed a wide range of activities in physically and emotionally demanding circumstances. As a result, the response and ensuing years presented unique opportunities for government, industry, and the public health/medical community partners to expand their knowledge and understanding for protecting workers and the public in complex, large-scale, emergency responses. The two recommendation areas that are addressed in the safety section include the following:

- S1 – Responder Safety.
- S2 – Pubic Health.

Each recommendation area is supported by a number of specific recommendations that are related to the area. In addition to the specific safety recommendations, there are some policy-related recommendations that, if addressed, would improve ISB safety. This gap analysis does not specifically address the topic of Personal Protective Equipment (PPE) requirements. There is a need to ensure that PPE recommendations are practical, given the environment and working conditions the responders will face; and those needs have been identified and are being addressed by NIOSH in other forums.

## 3.1 Responder Safety Overview

Based on the Gaps Analysis and the expert opinions of response workers from government and industry who participated in the DWH response and follow-up research, four significant recommendations were identified. Table 3-1 summarizes the responder safety recommendations.

Table 3-1. Recommendations for S1 - Responder safety.

| S1 | Responder Safety |
|---|---|
| S1.1 | Conduct long-term monitoring of spill responders' health. (The NIEHS GuLF study is ongoing for responders and affected public.) |
| S1.2 | Assess and determine the need for detailed intervention protocols to detect and control the possible exposure effects, including performing the immediate collection of biological samples from response workers to establish the levels of individual internal exposure effects at the acute and chronic level, especially those related to genotoxicity. When conducting post health assessment surveys consider capturing specific demographics from responders to include the type of operations they were conducting. This approach could help contrast the level of exposure from different types of response techniques. |
| S1.3 | Establish long-term monitoring for potential health effects from ISB-generated air pollutants in responders. |

### 3.1.1 Status of Recommendations

Limited (L): Interest expressed, with some activity
Moderate (M): Interest, research ongoing
Significant (S): Funding provided, underway

**S1.1**. Once fully operational, the health and safety requirements established during the Deepwater Horizon response were effective in documenting and protecting worker safety and public health. Initial exposures were often disregarded, or were under reported, in the height of the emergency response as urgency was the priority in fighting the fire, locating the missing, and initiating the response. As the response expanded throughout the Gulf, teams of toxicologists and industrial hygienists from government and industry were assembled to assess potential risks in the response working environment, including those risks to human health from the oil itself and the chemical dispersants used and in-situ burning efforts in the Gulf. (S)

**S1.2/1.3**. An environmental testing and monitoring program was created for oil recovery and clean-up operations, and to help increase awareness of any potential health and environmental impacts of the Deepwater Horizon accident. Protocols and safety and health strategies were authorized. Of particular note were the Human Health Considerations identified by the JITF. An in-situ burn of oil generates several suspected human carcinogens that can be found in soot particles of the resultant smoke plume. The operational and science of ISB is known; however, existing research on responder and public health exposures and consequences were not well known by the medical and public health communities; and, therefore, were seen as a significant information gap. One of the key safety issues identified by the JITF focused on the health impacts from smoke and soot exposure by responders. The JITF recommended that a monitoring plan be established that incorporates "*safety advisors who support on-water in situ burning operations… be given training to enable them to perform any air monitoring and oil vapor exposure tasks*." Another key aspect of this type of research would be to help contrast the levels of exposure associated with different types of response techniques; and perhaps help with making decisions based on a better understanding of responder risks. (S)(M)

### 3.1.2 Impact of Implementation

Current health and safety protocols are excellent; the DWH response conducted over 375 significant operational burns with no work injuries reported. Air quality monitoring for the ISB operations vessels provided guidance to the operators on responder inhalation exposures. Ultimately, the impact of the existing safety protocols and future best management practices will improve the safety and health of response workers and the public during future responses where in-situ burning is used.

The new safety requirements will increase the operational health and safety of the response workers. The existing and future scientific data and best management practices will provide the necessary information to allow the Incident Command and Command Staff to make better, more informed decisions regarding the health and safety of responders and the public.

### 3.1.3 Summary Table

Table 3-2 below summarizes the Responder Health recommendations. The table includes a specific recommendation for future research in the area of maintaining and improving the medical monitoring plan.

Table 3-2. ISB Gap Analysis and Recommendations for S1 - Responder health.

| |
|---|
| **Applicability:** |
| Operations – level: Plan writers, ISB operators (those that carry out the tactics), aerial observers, safety personnel (operations/public health), wildlife monitors |
| **Recommendation(s):** |
| **S1.1** Long-term monitoring of Deepwater Horizon responders' health and health of the community in the most affected coastal areas<br>• Continue the NIEHS Gulf Coast Cohort study investigating the health effects of exposed cleanup workers<br>**S1.2** Consider the value of taking biological samples from cleanup workers before or immediately after their exposure to oil to establish a baseline from which to conduct research into long-term health impacts. Establish detailed intervention protocols that include some mechanisms to detect and control the possible harmful effects that exposure can induce, including performing the immediate collection of biological samples from the beginning of the cleanup work, in order to establish the levels of individual internal exposure effects at the acute and chronic level, especially those related to genotoxicity.<br>**S1.3** Need monitoring for potential and long-range health effects of air pollutants from burning oil for workers. |
| **Extent which the recommendation has been addressed or implemented:** |
| **S1.1** National Institutes of Health (NIH) – Gulf Long-term Follow-up (GuLF) Study for cleanup workers and volunteers<br>**S1.3** Medical Monitoring of response workers<br>**S1.3** Conduct exposure monitoring and health hazard evaluations (HHE) during responses[Occupational Safety & Health Administration (OSHA), EPA, National Institute for Occupational Safety and Health (NIOSH), industrial hygienists, etc.] to determine worker exposures and address by modifying response measures |
| **Impact of Recommendation:** |
| o Improved safety and health of response workers (and the public)<br>o Long-term medical monitoring<br>o Better, more informed decision-making<br>o Better documentation for use of in-situ burning and the likely affects and impacts from the public and environment that may be in the plume path |
| **Description of proposed tasks for Recommendation for Future Research Efforts Related to Each Future Research Effort:** |
| **S1.4** Maintain and improve the medical monitoring program.<br>**Potential Policy Needs:**<br>o **All**. NRT incorporation into recommended best practices.<br>o **S1.2 and S1.3**. Establish more detailed requirements in the USCG IMH to ensure medical monitoring requirements are in place and followed during a response.<br>o **All**. Incorporate safety requirements into RRT and Area Committee planning documents. |

Table 3-2. ISB Gap Analysis and Recommendations for S1 - Responder health (Continued).


| List of Key References Used: |
|---|
| Aguilera, F., J. Mendez, E. Pasaro, and B. Laffon. 2010. Review on the Effects of Exposure to Spilled Oils on Human Health. *J. App. Toxicol*. 2010; 30: 291-301. |
| Kitt, M.M., J.A. Decker, L. Delaney, R. Funk, J. Halpin, A. Tepper, J. Spahr, and J. Howard. 2011. Protecting Workers in Large-scale Emergency Responses: NIOSH Experience in the Deepwater Horizon Response. *J. Occ. Env. Medicine*, 53(7): 711-715. |
| National Commission on the BP Deepwater Horizon Oil spill and Offshore Drilling. 2011. Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling. Report to the President. 398 p. |
| U.S. Environmental Protection Agency (EPA) Office of Research and Development. 2011. Draft Oil Spill Research Strategy. Report No. 11-P-0534, August 25, 2011. 42 p. |
| U.S. Coast Guard (USCG). 2014. Incident Management Handbook. U.S. Coast Guard COMDTPUB P3120.17B. May 2014. 382 p. |
| U.S. Coast Guard. 2011. BP Deepwater Horizon Oil Spill: Incident Specific Preparedness Review (ISPR) and Memorandum. ADM R.J. Papp, Jr. Prepared for Department of Homeland Security. |
| Weinhold, B. 2010. Spheres of Influence: Emergency Responder Health: What Have We Learned from Past Disasters? *Env. Health Perspectives*, 118(8): A346-A350. |


## 3.2 Public Health Safety Overview

In addition to the health and safety concerns associated with responders, the Gap Analysis identified a number of public health concerns that were associated with the DWH spill. Several of the recommendations mirror concerns for responders (exposure to oil, inhalation hazards, long-term health effects) and others are related to the population who reside in the spill area and may have impacts from consumption of seafood or suffer from long-term health impacts. Table 3-3 summarizes the recommendations for S2- Public Health.

Table 3-3. Recommendations for S2 - Public health.

| Area | Recommendations |
|---|---|
| S2.1 | Protect the health of affected populations from the Deepwater Horizon oil spill and future public health disasters. |
| S2.2 | Need to research the causal or correlative relationships between chemical (i.e., oil and dispersants) exposure and human health. |
| S2.3 | Determine public health effects on the population from contact with the oil and its vapors; additionally, determine cardiovascular health effects from exposure to in-situ burn smoke plumes. |
| S2.4 | Develop accurate data on how far downwind PM-10 generated from an oil spill is measurable. |
| S2.5 | Determine seafood safety consumption standards for public health. |

### 3.2.1 Status of Recommendations

Limited (L): Interest expressed, with some activity
Moderate (M): Interest, research ongoing
Significant (S): Funding provided, underway

**S2.1**. See recommendation S1.2. (S)

**S2.2** and **S2.3**. As a follow-up to the on-scene public and responder health and safety efforts, the National Institutes of Health (NIH) initiated the Gulf Long-term Follow-up (GuLF) study to monitor how different aspects of oil-spill response may have affected the current and future health of cleanup workers and volunteers. The study also examines how stress and job loss because of the oil spill can affect health, including mental health. (S)

**S2.3**. As a result of the JITF's evaluation and continued research, the In-Situ Burn Subcommittee developed the draft "*Guidelines for Safety and Industrial Hygienists*," which is presently being finalized and will be submitted for public access. (S)

**S2.4**. Comprehensive air and water monitoring programs were established to monitor the health and safety of residents and responders. Guidance was provided on exposure and health responses by the Centers for Disease Control and Prevention (CDC), NIOSH, and OSHA. More than 30,000 response worker personal monitoring samples were collected in order to monitor and help prevent response workers' exposures to chemicals released from fresh and weathered crude oil, dispersants, and in-situ burning plumes. To help protect the health and safety of residents and responders, data and information from the environmental monitoring programs were shared among the federal responding agencies, BP, and the affected state and federal agencies. Sampling results were published and shared on several government and the BP websites.[5](L)

**S2.5**. Seafood safety was an additional component of the Deepwater Horizon Response as the Gulf Coast provides 82 percent of the U.S. total commercial shrimp landings and 59 percent of the oyster production (EPA GOM Program 2010 estimates)[6]. The seafood industry is a significant part of the Gulf Coast economy and diet of its residents. As such, the Gulf seafood is the most "*rigorously tested sources of seafood on the market today. In addition to testing by the National Oceanic and Atmospheric Administration (NOAA) and the US Food and Drug Administration (FDA), Gulf states continued to conduct extensive seafood sampling and analysis in 2013.*"[7](M)

In-situ burning yields both a smoke plume and a burn residue (the result of incomplete combustion); depending on the oil burned, the residue can sink and cause environmental concerns on the sea floor where it accumulates and for resources that inhabit these areas. As a result, NOAA identified the need for "*chronic toxicity testing using burn residues, benthic organisms and habitats, and realistic exposure levels and pathways*."[8]

Schaum et al (2010) conducted screening level risk assessments to estimate the potential cancer risks to human populations that may have resulted from exposure to dioxins created by the ISB operations. The pathways considered in this study included inhalation by workers, inhalation by residents living onshore, as well as ingestion of fish by residents (seafood consumption).

Figure 2-3 shows the distribution of participants in the GuLF study.

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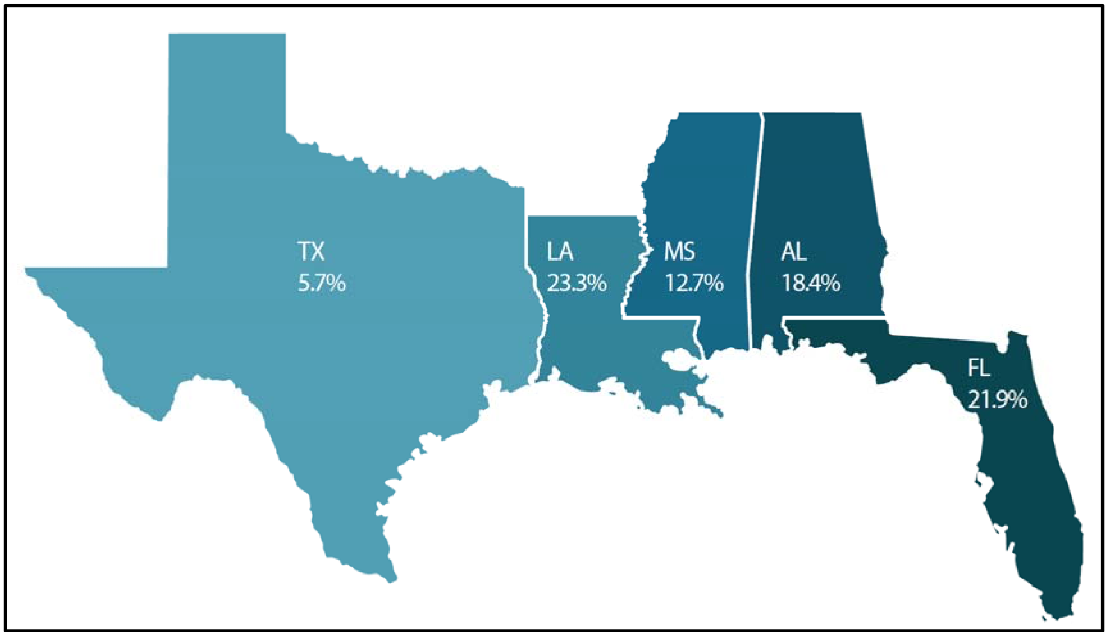
[5] From: http://www.bp.com/en/global/corporate/gulf-of-mexico-restoration/deepwater-horizon-accident-and-response/health-and-safety-in-the-response-effort.html.
[6] From: US EPA Gulf of Mexico Program webpage, http://www.epa.gov/gmpo/about/facts.html; accessed 12/5/2014.
[7] From: BP Seafood Industry Recovery webpage, http://www.bp.com/en/global/corporate/gulf-of-mexico-restoration/restoring-the-economy/seafood-industry-recovery.html; accessed 12/5/2014.
[8] From: NOAA's Office of Response and Restoration Residues from In Situ Burning of Oil on Water webpage, http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/residues-in-situ-burning-oil-water.html; accessed 12/5/2014.




*(18 percent of the study participants live outside of the Gulf Coast Region).*[9]

Figure 2-3. Distribution of participants for the GuLF study.

In addition to the GuLF Study, the U.S. oil and natural gas industry initiated a comprehensive review of offshore safety for their industry. The Joint Industry Oil Spill Preparedness and Response Task Force, one of four task forces established, conducted an assessment of the Deepwater Horizon response—focusing in on the areas (response topics) of the response that were identified as needing further study. Industry experts were brought together to identify best practices in offshore drilling operations and oil spill response in order to enhance safety and environmental protection.

In-situ burning was a highly valuable component of the DWH response that would not have been possible without the research and regulatory changes of the past 20 years. However, ISB technology remains limited by the performance parameters; similar to dispersant use, misperceptions and knowledge gaps led to delays in utilizing ISB, which resulted in missed opportunities to remove more oil from the water. (JITF, 2010)

### 3.2.2 Impact of Implementation

Efforts by the response community to document individual exposures and provide better documentation when conducting an in-situ burn will provide a significant knowledge base on the likely effects and impacts from the public and environment that may be in the plume path.

The procedures established for monitoring seafood safety and health effects from seafood consumption in the affected area. Research during and in the three years following the DWH oil spill response has shown that the cancer risk in fish and shellfish is nearly non-existent for population. The Gulf of Mexico residents consume nearly four times the amount of seafood than the general U.S. population; thus, their exposure risks are significantly higher than typical consumers. However, even individuals with high daily fish and shellfish consumption rates, the cancer risk is negligible.

[9] Source: GuLF Study Newsletter, Issue 1, October 2013. Available online from https://gulfstudy.nih.gov/en/GuLF%20STUDY%20newsletter,%20Issue%201%20%28English%29.pdf.

### 3.2.3 Summary Table

Table 3-4 below summarizes the Public Health recommendations. The table includes a specific recommendation for future research in the area of better coordination with industry on the development and implementation of specific public health protocols.

Table 3-4. ISB Gap Analysis and Recommendations for S2 - Public health.

| **Applicability:** | |
|---|---|
| General Public; those individuals who are directly affected by an incident, community members, and other Stakeholders (all those at the community level with whom the local authorities may engage) | |
| **Recommendation(s):** | |
| **S2.1** | More information is needed to best protect the health of affected populations in the contexts of the Deepwater Horizon oil spill and future public health disasters |
| **S2.2** | Need to research the causal or correlative relationships between chemical (i.e., oil and dispersants) exposure and human health |
| **S2.3** | Determine Health effects on the population:<br>• Determine the effects of dermal contact with oil<br>• Determine whether neurological effects when exposed to a mixture of hydrocarbon vapors is worse than the sum of the effects of exposure to individual vapors<br>• Determine the dose-response function for acute exposures to hydrocarbon vapors<br>• Determine the cardiovascular effects associated with exposure to smoke plumes from in-situ burns |
| **S2.4** | Develop accurate data on how far downwind PM-10 generated from an oil spill is measurable and assess the need for further evaluation of the impacts of PM-2.5 vs PM-10 particulate sizes |
| **S2.5** | Seafood safety and consumption issues |
| **Extent which the Recommendation has been Addressed or Implemented:** | |
| **S2.1** | Public Health Effects Research from Deepwater Horizon:<br>• National Institutes of Environmental Health Sciences (NIEHS) Gulf Long-term Follow-up (GuLF) Study for cleanup workers and volunteers and other exposed gulf residents.<br>• Health Effects Surveillance by the CDC/ATSDR.<br>• NIOSH/OSHA developed DWH Guidance for Workers.<br>• Numerous Independent Research by Medical Community. |
| **S2.1** | JITF - *Guidelines for Safety and Industrial Hygienists*—draft document for ISB reviewed by workgroup |
| **S2.2** | Work already conducted by CDC.**S2.3** Additional research by medical community is ongoing. |
| **S2.4** | Special Monitoring of Applied Response Technologies (SMART) addresses this; PM2.5 is also being addressed by EPA. |
| **S2.5** | Numerous research studies on seafood safety and human consumption has been conducted since the Deepwater Horizon response (FDA, NOAA); research is ongoing. |
| **Impact of Recommendation:** | |
| o Improved safety and health of response workers (and the public)<br>o Better, more informed decision-making<br>o Better documentation for use of in-situ burning and the likely affects and impacts from the public and environment that may be in the plume path | |

Table 3-4. ISB Gap Analysis and Recommendations for S2 - Public health (Continued).

| **Description of Proposed Tasks for Recommendation for Future Research Efforts:** |
|---|
| **S2.1** Maintain the NIEHS medical monitoring program<br>**S2.2** Coordinate with Industry on human health and safety requirements<br>**S2.3** Continue research<br>**S2.4** Continue research<br>**S2.5** FDA and NOAA continue seafood safety monitoring programs<br>**Potential Policy Needs:**<br>o **All** NRT incorporation into recommended best practices<br>o **All** Establish more detailed requirements in the USCG Incident Management Handbook (IMH) to ensure medical monitoring requirements are in place and followed during a response<br>o **All** Incorporate safety requirements into RRT and Area Committee planning documents |
| **List of Key References Used:** |
| Aguilera, F., J. Mendez, E. Pasaro, and B. Laffon. 2010. Review on the Effects of Exposure to Spilled Oils on Human Health. *J. App. Toxicol*. 2010; 30: 291-301.<br>Food and Drug Administration (FDA) 2010. Gulf of Mexico Oil Spill Update. Available: http://www.fda.gov/Food/FoodSafety/Product-SpecificInformation/Seafood/ucm210970.htm#background_testing<br>Gohlke, J.M., D. Dzigodi, M. Tipre, M. Leader, and T. Fitzgerald. 2011. A Review of Seafood Safety after the Deepwater horizon Blowout. Environ Health *Perspect*. 119: 1062-1069.<br>National Commission on the BP Deepwater Horizon Oil spill and Offshore Drilling. 2011. Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling. Report to the President. 398 p.<br>Schaum, J., M. Cohen, S. Perry, R. Artz, R. Draxler, J.B. Frithsen, D. Heist, M. Lorber, and L. Phillips. 2010. Screening Level Assessment of Risks Due to Dioxin Emissions from Burning Oil from the BP Deepwater Horizon Gulf of Mexico Spill. *Environ. Sci. Technol*. 2010, 44: 9383-9389.<br>Solomon, G.M. and S. Janssen. 2010. Health Effects of the Gulf Oil spill. JAMA. September 8, 2010, 304(10):1118-1119.<br>U.S. Environmental Protection Agency (EPA) Office of Research and Development. 2011. Draft Oil Spill Research Strategy. Report No. 11-P-0534, August 25, 2011. 42 p.<br>U.S. Coast Guard (USCG). 2014. Incident Management Handbook. U.S. Coast Guard COMDTPUB P3120.17B. May 2014. 382 p.<br>U.S. Coast Guard. 2011. BP Deepwater Horizon Oil Spill: Incident Specific Preparedness Review (ISPR) and Memorandum. ADM R.J. Papp, Jr. Prepared for Department of Homeland Security. |

# 4 ISB RESEARCH RECOMMENDATION

While laboratory testing is helpful to obtain data about controlled burning, it is difficult to mimic in the laboratory the many variables of actual conditions that can be encountered in the field. Both decision-makers and the public have many area-specific questions about burn rates of various oils, the content of their atmospheric emissions, residues, and distribution of plumes. Field testing and data gathering will be needed to improve our ability to address decision-maker, public, non-governmental organizations, and academic questions.

## 4.1 Tank Tests and Field Trials

### 4.1.1 Overview

Based on the Gaps Analysis and the expert opinions of response workers from government and industry who participated in the DWH response and follow-up research, a gap was highlighted as needing additional research:

- R1 - Tank Tests and Field Trials.

This area is supported by a specific recommendation that is related to the area. In addition to the specific research recommendations, there are some policy-related recommendations that, if addressed, would improve ISB operations and safety. Table 4-1 summarizes the recommendation for tank tests and field trials.

Table 4-1. Recommendations for R1 - Tank Tests and field trials.

| Area | Recommendations |
|---|---|
| R1.1 | Field trials and study of actual spills where ISB is conducted are needed to determine whether or not the small scale test data and predictive models developed to date apply to large burns. |

There are significant linkages between the various recommendations identified in this study. The research recommendation for tank tests and field trials is directly associated and is a component of recommendations for the OP2 - Ignition and Fire Boom Testing, as well as OP3 - Tactics and Support. To provide the means for fully evaluating the various recommendations, each is listed in only one recommendation area, but is referred to within the text and the summary table where overlap occurs.

### 4.1.2 Status of Recommendations

Limited (L): Interest expressed, with some activity
Moderate (M): Interest, research ongoing
Significant (S): Funding provided, underway

**R1.1**. ISB research studies are being conducted using tank tests and field trials; however, many of these studies involve the testing of ISB under various Arctic and ice conditions [investigators include: SL Ross, SINTEF/JIP, and International Oil and Gas Producers Association (IOGP)]. The conditions of this evaluation determined that data gaps and recommendations pertaining to Arctic and in ice references were not to be included; however, those recommendations that applied to both ice and no-ice conditions were

acceptable for inclusion. These recommendations were reported as part of the OP2 - Ignition and Fire Boom Testing, as well as OP3 - Tactics and Support. (L)

Furthermore, many of the ISB studies utilize computer modeling to propose the likely outcomes for a specific estimation. Without the use of tank tests and field trials, researchers cannot validate and further refine their computer modeling to better reflect the realities of an ISB; the use of tank tests and field trials are recommendations for validating the models.

#### 4.1.3 Impact of Implementation

Al Allen stated that “We can conduct limited tests with burning gas (propane); however, such tests do not include many of the conditions needed for sustained realistic burns with oil.” There is a strong need to identify an existing (or build a new) oil test facility in the U.S. where full-scale igniter and fire boom tests can be conducted. We also need to work with federal and state regulators, industry, lawyers that influence these groups, and the public to recognize the need for full-scale at-sea trials with oil. Imagine how effective our fire fighters (on-land, aircraft, and marine) would be if they were told that they could not deliberately burn buildings, aircraft, and vessels just for practice because it would make smoke.

The DWH response lessons have resulted in a renewed awareness of the benefit of further in-situ burning research and development. Industry technical work groups are currently identifying and prioritizing ISB R&D projects; a few of the more active organizations are the American Petroleum Institute (API) Joint Industry Task Force (JITF), the IOGP, and the International Maritime Organization (IMO). The long term objective of these and other research efforts is to ensure that a safe and efficient ISB process is developed for offshore spills. The use of large-scale tank tests to expand laboratory test data provides realism to the research; the use of field trials further refines the realities of conducting an ISB in the environment.

Currently, it is very difficult to obtain permission to conduct at-sea field trials, using spilled oil, in the U.S. As a result, large-scale tank tests for ISB are the current limits of testing for ISB research. The Joint Maritime Test Facility (JMTF) located in Mobile, Alabama, provides a maritime test environment, allows for the conduct of future burns, confirms the status of new research, and conducts initial burns in the burn tank at JMTF. The research identified in this Gap Analysis will ultimately further define the science of ISB: improving ISB operations by possibly extending the operational capabilities and conditions in which ISB response operations are considered effective and safe on water. Furthermore, many of the ISB studies utilize computer modeling to propose the likely outcomes for a specific estimation (e.g., burn residue). With the application of tank tests and field trials, researchers can validate and refine computer modeling to better reflect the realities of an ISB.

#### 4.1.4 Summary Table

Table 4-2 below summarizes the Tank Tests and Field Trials. The table includes a specific recommendation for future research in the area of identifying additional specialized testing tanks to continue ongoing controlled ISB R&D efforts. Specifically, conduct additional testing within specialized tanks, such as the Joint Maritime Test Facility (JMTF) in Mobile, AL, to study all aspects of controlled ISB, including the use of herders to enhance controlled ISB operations.

Table 4-2. ISB Gap Analysis and Recommendations for R1 -Tank tests and field trials.

| **Applicability:** |
|---|
| Plan-writers ISB Division/Group Supervisors, and controlled ISB operators (those that carry out the tactics) |
| **Recommendation(s):** |
| **R1.1**<br>• Field trials and study of actual spills where controlled ISB are conducted to determine whether or not the small scale test data and predictive models developed, to date, apply to large burns. (*See also OP2*) |
| **Extent which the recommendation has been addressed or implemented:** |
| **R1.1**<br>• Ongoing research<br>• Some laboratory and field trials conducted by SL Ross, JIP, and SINTEF. |
| **Impact of Recommendation:** |
| o Improved operational ISB operations efficacy/efficiency.<br>o Expand operational window of opportunity and response effectiveness.<br>o Results to be used to refine models that predict residue behavior. |
| **Description of Proposed Tasks for Recommendation for Future Research Efforts:** |
| **R1.1**<br>• Additional specialized testing tanks should be identified to continue ongoing controlled ISB R&D.<br>• Additional R&D/testing within specialized tanks (at JMTF) should be designed to study all aspects of controlled ISB, including the use of herders to enhance controlled ISB operations.<br>**Potential Policy Needs**:<br>• Coordinate with agencies and the public to develop and promulgate policy on when full-scale at-sea trails can be conducted with oil. |
| **List of Key References Used:** |
| National Response Team (NRT) Science and Technology (S&T) Committee. 2000. Fact Sheet: Residues from In Situ Burning of Oil on Water. January 2000. 2 p.<br>U.S. Coast Guard (USCG). 2014. Incident Management Handbook. U.S. Coast Guard COMDTPUB P3120.17B. May 2014. 382 p. |

# 5 SIMULTANEOUS OPERATIONS (SIMOPS)

A number of the recommendations in Section 2 address specific tactics, equipment, and training issues associated with ISB operations. While these areas need to be addressed and will improve the efficacy and safety of ISB operations, the Gap Analysis also identified recommendations for improvements in other areas that will also impact the efficacy and safety of ISB operation. Those recommendations focus on the conduct of other response techniques (mechanical recovery, dispersant application) concurrent with ISB operations, recognizing that on a large-scale spill response there will be more than one type of cleanup technique applied. Based on the Gap Analysis and the expert opinions of response workers from government and industry, who participated in the DWH response and follow-up research, the following recommendation is highlighted in the gap analysis:

- P1 - Simultaneous Operations (SIMOPS).

Each recommendation area is supported by a number of specific recommendations that are related to the area. In addition to the specific training recommendations, there are some policy-related recommendations that, if addressed, would improve ISB operations and safety.

## 5.1 Simultaneous Operations (P1)

### 5.1.1 Overview

Controlled ISB operations are typically conducted in conjunction with other spill response techniques, which most commonly include mechanical recovery and the application of dispersants. The DWH Incident Specific Preparedness Review (ISPR) noted the following, "…efforts to contain, control, and remove the oil at the well and offshore areas provided the first line of defense for protecting Environmentally Sensitive Areas (ESAs). While they did not prevent oiling and impact to shorelines and ESAs, the use of the full range of response tools, including mechanical removal, dispersants, and in-situ burning, diminished immediate ESA impacts." Each operation, when conducted on the scale of DWH spill operations, requires a significant level of coordination for effective operations in the offshore environment. The recommendation in this area focuses on ensuring that ISB operations are coordinated with, and complimentary to, other response techniques and includes the need to address the following elements:

- Recommendations for managing and coordinating multiple response tactics 5-50 NM offshore.
- Communications requirements and methodology (air to ground observers, etc.).
- Operating zone establishment guidelines for burn boxes/circles, recovery boxes, and application zones.
- Better management of both the spatial and temporal aspects of all response operations in order to ensure one action would not reduce the effectiveness of the other.

Table 5-1 summarizes the recommendation for P1 - Simultaneous Operations.

Table 5-1. Recommendation for P1 - Simultaneous operations.

| Area | Recommendation(s) |
|---|---|
| P1.1 | Need additional research to further develop a consistent response strategy for using ISB in conjunction with mechanical recovery and aerial dispersants that is refined, communicated, coordinated, and executed to maximize the removal of oil from surface waters during a response. |

### 5.1.2 Status of Recommendations

Limited (L): Interest expressed, with some activity
Moderate (M): Interest, research ongoing
Significant (S): Funding provided, underway

**P1.1**. The Gap Analysis did not identify any significant progress in this area. The post DWH focus appears to be more on assessing the performance of each individual response technique as opposed to looking for ways to ensure that simultaneous operations are coordinated.(M)

### 5.1.3 Impact of Implementation

Documenting the conduct of DWH simultaneous operations and capturing lessons learned from a broader perspective would help to improve both operations and safety, not just in ISB operations but for each operation being conducted. Providing a structure/process for coordination of all operations will maximize the benefits of all response technologies when used separately and, most importantly, when used simultaneously. Developing sound guidance enables members of the Unified Command to develop an incident response strategy that uses all of the assets available to maximize the removal of surface oil and reduce the environmental damage of a spill. The strategies developed should consider the benefits and timeliness of each response methodology—dispersant, mechanical recovery and controlled ISB—and how best they can each be used (simultaneously/concurrently) to minimize shoreline and wildlife impacts and damages.

### 5.1.4 Summary Table

Table 5-2 below summarizes the Simultaneous Operations recommendation. The table includes a specific recommendation for future research in the area of developing response strategies that anticipate and plan for the concurrent application of multiple response strategies.

Table 5-2. ISB Gap Analysis and Recommendations for P1 - Simultaneous operations.

| **Applicability:** |
|---|
| o Operations Level: Plan writers, in-situ burn operators (those that carry out the tactics), aerial observers safety personnel (operations/public health), wildlife monitors,<br>o Counterparts within Dispersant and mechanical recovery operations<br>o Awareness Level: FOSC-R, FOSC, RRTs, and Area Committees, Incident Command |
| **Recommendation(s):** |
| **P1.1**<br>• Controlled ISB is generally conducted concurrent with and simultaneous to dispersant and mechanical recovery operations. Need additional research to further develop a consistent response strategy for using aerial dispersants in conjunction with mechanical recovery and in-situ burning that is refined, communicated, coordinated and executed to maximize the removal of oil from surface waters during a response. It should include:<br>o Recommendations for managing and coordinating multiple response tactics 5–50 NM offshore<br>o Communications requirements and methodology (air to ground observers, etc.)<br>o Operating zone establishment guidelines for burn boxes/circles, recovery boxes, and application zones<br>o Better manage both spatial and temporal aspects of all response operations in order to ensure one action would not reduce the effectiveness of the other |
| **Extent which the recommendation has been addressed or implemented:** |
| o Unknown |
| **Impact of Recommendation:** |
| o Maximize the benefits of all response technologies when used separately and, most importantly, when used simultaneously |
| **Description of Proposed Tasks for Recommendation for Future Research Efforts:** |
| **P1.1**<br>• Develop sound guidance so that the Unified Command can develop an incident response strategy that uses all of the assets available to maximize the removal of surface oil and reduce the environmental damage of a spill and assists in providing:<br>o Primary response objectives and metrics for offshore oil spills, the most expeditious removal of the most oil from surface waters that is consistent with safe practices and other response objectives.<br>o Priorities and strategies on how best to simultaneously use mechanical recovery, dispersants, and in-situ burning to maximize total surface oil removal.<br>• Review the various scenarios for the worst-case discharges, review currently available response assets and their capabilities to respond to these scenarios and develop response strategies that maximize surface oil removal. The strategies developed should consider the benefits and timeliness of each response methodology—dispersant, mechanical recovery, and controlled ISB—and how best they can each be used (simultaneously/concurrently) to minimize shoreline and wildlife impacts and damages. |
| **List of Key References Used:** |
| Allen, A.A. 2011. Presentation: In-situ Burn Operations during the Deepwater Horizon Oil Spill. OSPR / Chevron Oil Spill Response Technology Workshop: Chevron Park – San Ramon, California, February 15-17, 2011. 33 slides.<br>Houma ICP Aerial Dispersant Group. 2010. After Action Report: Deepwater Horizon MC252 Aerial Dispersant Response. Prepared for the Region 6 Regional Response Team. December 31, 2010. 80 p.<br>U.S. Coast Guard. 2011. On Scene Coordinator Report: Deepwater Horizon Oil Spill. Submitted to the National Response Team, September 2011. 244 p. |

# 6 SUMMARY OF RECOMMENDATIONS FOR FUTURE ISB RESEARCH

The following section provides and assessment of which of the recommendations discussed in Sections 2-5 of the Gap Analysis Report have the potential for future research. These recommendations are based on subject matter expert opinion and are categorized by how each relates to Operations, Safety, Research, and whether or not the team felt that the Joint Maritime Test Facility could be engaged in meeting that recommendation. Table 6-1 provides recommendations for future In-Situ Burn (ISB) research.

Table 6-1. Recommendations for future In-Situ Burn (ISB) research.

| Recommendation Description | Applicability | | | | |
|---|---|---|---|---|---|
| | Ops | Safety | Research | Policy | JMTF |
| Improve onboard and air-to-ground radio communications links, Automatic Identification System (AIS), and live video coverage from shore-based and vessel mounted systems. | ✔ | ✔ | ✔ | | ✔ |
| Develop tools and associated guidance documents (e.g., ISB calculator such as NOAA's Dispersant Mission Planner) for 33 CFR Facility Planning Requirements. | | | | ✔ | |
| Create a guidance document on required operational parameters for on-water in-situ burning that addresses the entire operation and includes the operational communications aspects of the operation. | ✔ | | | ✔ | |
| Develop pre-approved plans that enable responders to take advantage of spills of opportunity to test response equipment. | ✔ | ✔ | | | |
| Develop equipment and techniques to expand the ISB window of opportunity (e.g., higher wind and sea states). | ✔ | | ✔ | | ✔ |
| Conduct additional testing on the use of open-apex deflection systems to increase the encounter rate for ISB operations. | ✔ | | ✔ | | ✔ |
| Test the deployment of unmanned aircraft and vessels for burn ignition and herder application. | ✔ | ✔ | ✔ | ✔ | ✔ |
| Test and evaluate equipment and procedures to recover burn residue. | ✔ | | ✔ | | ✔ |
| Conduct tests to determine the appropriate herder/demulsifier deployment scenarios/conditions, sea state conditions, water temperature, etc. | ✔ | | ✔ | | ✔ |
| Recommend that the NRT establish and house a publically available data library of all ISB (and dispersant, etc.) references. Further recommend that this data library is routinely reviewed and a consistent process for reporting on key concepts and advances in controlled ISB Operations is developed. | ✔ | ✔ | | ✔ | |
| Create training documents (Operations and Awareness levels) that reinforce terminal learning objectives related to operational parameters for on-water in-situ burning (how to do ISB). | ✔ | ✔ | | ✔ | |

Table 6-1. Recommendations for future In-Situ Burn (ISB) research (Continued).

| Recommendation Description | Applicability | | | | |
|---|---|---|---|---|---|
| | Ops | Safety | Research | Policy | JMTD |
| Develop nationally consistent, hands-on training courses for Operations Level ISB that tests trainee's knowledge of how to conduct the full suite of ISB operations. Operations Level training course to be conducted at the JMTD. | ✓ | ✓ | | | ✓ |
| Develop a nationally consistent course for Awareness-level operational ISB that provides guidance on notifying authorities, taking action to initiate ISB authorization, knowledge of ISB logistics and operational requirements, and command authority. Awareness level training to be sponsored at RRTs and Area Committees. | ✓ | ✓ | | | |
| Develop a National ISB Operator Certification Program. | ✓ | ✓ | | | |
| Recommend a process to track individuals who are trained/certified in ISB operations. | ✓ | ✓ | | | |
| Create a nationally consistent, ISB table-top training course that is exportable and/or part of other oil spill exercise programs. | ✓ | ✓ | | | |
| Assess the current medical monitoring program and determine whether there are any areas for improvement. | | ✓ | | ✓ | |
| Develop procedures for better coordination with industry on the development and implementation of specific public health protocols. | | ✓ | | ✓ | |
| Conduct additional R&D/testing within specialized tanks that are designed to study all aspects of controlled ISB, including the use of herders to enhance controlled ISB operations. | ✓ | ✓ | ✓ | | ✓ |
| Develop sound guidance on coordination of response techniques/strategies so that the Unified Command can develop an incident response strategy that uses all of the assets available to maximize the removal of surface oil and reduce the environmental damage of a spill. | ✓ | ✓ | | ✓ | |
| Review the various scenarios for the worst-case discharges, review currently available response assets and their capabilities to respond to these scenarios and develop response strategies that maximize surface oil removal. The strategies developed should consider the benefits and timeliness of each response methodology—dispersant, mechanical recovery, and controlled ISB—and how best they can each be used (simultaneously/concurrently) to minimize shoreline and wildlife impacts and damages. | ✓ | ✓ | | ✓ | |
| Once developed, use the ASTM F20.15 Standard Guide for Evaluation of In-situ Burning Effectiveness Potential to test the effectiveness of the standard for allowing ISB workers to accurately and consistently document and calculate the amount of oil burned within the area of a burn. | | ✓ | | ✓ | ✓ |

# 7 REFERENCES


Allen, A.A. 2011. PRESENTATION: In-situ Burn Operations during the Deepwater Horizon Oil Spill. OSPR / Chevron Oil Spill Response Technology Workshop: Chevron Park – San Ramon, California, February 15-17, 2011. 33 slides.

Allen, A.A., N.J. Mabile, D. Jaeger, and D. Costanzo. 2011. The Use of Controlled Burning during the Gulf of Mexico Deepwater Horizon MC-252 Oil Spill Response. In: *Proceedings of the 2011 International Oil Spill Conference*. Portland, OR, USA

Buist, I., S.G. Potter, B.K. Trudel, S.R. Shelnutt, A.H. Walker, D.K. Scholz, P.J. Brandvik, J. Fritt-Rasmussen, A.A. Allen, and P. Smith. 2013. In-Situ Burning in Ice-Affected Waters: State of Knowledge Report. Prepared for the International Association of Oil & Gas Producers. 316 p.

Joint Industry Task Force Progress Report on Industry Recommendations to Improve Oil Spill Preparedness and Response. 2012. Second Progress Report on Industry Recommendations to Improve Oil Spill Preparedness and Response. November 16, 2012. 27 p.

Joint Industry Oil Spill Preparedness and Response Task Force. 2012. Executive Summary. March 2012. 9 p.

National Commission on the BP Deepwater Horizon Oil spill and Offshore Drilling. 2011. Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling. Report to the President. 398 p.

Oil Spill Preparedness and Response (OSPR) and Chevron. 2011. OSPR / Chevron Oil Spill Response Technology workshop Draft Agenda. Chevron Park – San Ramon, California, February 15-17, 2011. 3 p.

U.S. Coast Guard. January 2011. BP Deepwater Horizon Oil Spill: Incident Specific Preparedness Review (ISPR) and Memorandum. ADM R.J. Papp, Jr. Prepared for Department of Homeland Security.

**Web Links**

http://www.api.org/oil-and-natural-gas-overview/exploration-and-production/offshore/api-joint-industry-task-force-reports

The Use of Controlled Burning during the Gulf of Mexico Deepwater Horizon MC-252 Oil Spill Response, Alan A. Allen, Drew Jaeger, Nere J. Mabile and Don Costanzo, International Oil Spill Conference Proceedings Mar 2011, Vol. 2011, No. 1 (March 2011) pp. abs194

CG Incident Specific preparedness Review (ISPR) http://www.uscg.mil/foia/docs/dwh/bpdwh.pdf

President's Commission: http://www.gpo.gov/fdsys/pkg/GPO-OILCOMMISSION/pdf/GPO-OILCOMMISSION.pdf

Oil Spill commission Action: http://oscaction.org/

In-Situ Burn Operations during the Deepwater Horizon Oil Spill, Al Allen, OSPR/Chevron Oil Spill Response Technology Workshop, San Ramon, CA, Feb 15-17, 2011.

API Work Groups: http://www.api.org/news-and-media/docs/~/media/Files/News/2014/14-January/JITF-Newsletter-January2014.pdf

Joint Maritime Test Detachment (JMTD) Facility - brochure description

Gulf of Mexico Research Initiative: http://gulfresearchinitiative.org/

# APPENDIX A. DATA COLLECTION

The following is a listing of all the recommendations that resulted from our GFI review and literature review for the gap analysis project. This full list of recommendations was used by the team subject matter experts to focus the gap analysis on the recommendations that had the most potential to positively impact the efficacy and safety of ISB Operations.

Table A-1. Data collection.

| Identified Gap - Categorization | | | | Documents Reference | Gap Identified / Recommendation |
|---|---|---|---|---|---|
| Gap – Level 1 | | Gap – Level 2 | Gap – Level 3 | | |
| **ISB Operations Recommendations** | | | | | |
| **OP1.1** | **Operations** | Surveillance & Spotting | Communications | Allen, Mabile, Jaeger & Costanzo (2011) | Communications: improved onboard and air-to-ground radio communications links, AIS, and live video coverage from shore-based and vessel mounted systems needed. |
| **OP1.1** | **Operations** | Surveillance & Spotting | Communications | Allen (2011) Presentation | Need to address further: Encounter rate, Surveillance and spotting, Communications, Integration of response options |
| **OP1.1** | **Operations** | Surveillance & Spotting | Communications | JITF (2011) Oil Spill Preparedness and Response Recommendations | Develop technologies to improve oil and dispersant detection in the water column and seafloor |
| **OP1.1** | **Operations** | Surveillance & Spotting | Policy Change | Mabile (2012) The Coming of Age of Controlled In-Situ Burning: Transition from Alternative Technology to A Conventional Offshore Spill Response Option | Develop Communications Plan for ISB |
| **OP1.1** | **Operations** | Surveillance & Spotting | Policy Change | Mabile (2012) The Coming of Age of Controlled In-Situ Burning: Transition from Alternative Technology to A Conventional Offshore Spill Response Option | Develop Safety Plan for ISB |

Table A-1. Data collection (Continued).

| Identified Gap - Categorization | | | | Documents Reference | Gap Identified / Recommendation |
|---|---|---|---|---|---|
| Gap – Level 1 | | Gap – Level 2 | Gap – Level 3 | | |
| **OP1.1** | **Operations** | Surveillance & Spotting | Policy Change | Mabile (2012) The Coming of Age of Controlled In-Situ Burning: Transition from Alternative Technology to A Conventional Offshore Spill Response Option | Equipment pre-staging for quick deployment for supporting command, safety and control |
| **OP1.1** | **Operations** | Surveillance & Spotting | Policy Change | Mabile (2012) The Coming of Age of Controlled In-Situ Burning: Transition from Alternative Technology to A Conventional Offshore Spill Response Option | Pre-establish emergency contracts for aircraft and vessel usage |
| **OP1.1** | **Operations** | Surveillance & Spotting | Policy Change | Mabile (2012) The Coming of Age of Controlled In-Situ Burning: Transition from Alternative Technology to A Conventional Offshore Spill Response Option | Develop training program for new responders and stakeholders who may become involved in ISB operations |
| **OP1.1** | **Operations** | Surveillance & Spotting | Policy Change | JITF (2011) Oil Spill Preparedness and Response Recommendations | Develop and implement a pre-approval process for in situ burning to remove procedural obstacles to in situ burning that could compromise the rapidity and efficiency of an integrated response effort. |
| **OP1.1** | **Operations** | Surveillance & Spotting | Policy Change | JITF (2011) Oil Spill Preparedness and Response Recommendations | Agreements should be implemented uniformly across the United States to remove a potential conflict between emergency response needs and requirements for ambient air quality. |

Table A-1. Data collection (Continued).

| Identified Gap - Categorization | | | | Documents Reference | Gap Identified / Recommendation |
|---|---|---|---|---|---|
| Gap – Level 1 | | Gap – Level 2 | Gap – Level 3 | | |
| **OP1.2** | **Operations** | Surveillance & Spotting | Data Collection | USCG (2011) DWH ISPR | Develop a program to capture operational information and key lessons learned from the Deepwater Horizon incident and other tests and incidents involving ISB |
| **OP1.2** | **Operations** | Surveillance & Spotting | Data Collection | Marine Mammal Commission (2010) Letter | Develop online searchable database of relevant literature |
| **OP1.2** | **Operations** | Surveillance & Spotting | Data Collection | Marine Mammal Commission (2010) Letter | Create bibliography of research activities and new technologies |
| **OP1.2** | **Operations** | Surveillance & Spotting | Data Collection | Mabile (2012) The Coming of Age of Controlled In-Situ Burning: Transition from Alternative Technology to A Conventional Offshore Spill Response Option | Develop library of oil spill information and resources, including oil type (tendency to emulsify, volatility, burn rate, etc.), spreading and weathering data, meteorological and oceanographic data; and air, water, and wildlife monitoring plans. |
| **OP1.2** | **Operations** | Surveillance & Spotting | Data Collection | USCG (2011) DWH ISPR | Support research to develop standards and processes for the expedited collection, processing, correlation, analysis, and distribution of satellite imagery and oil thickness sensors to provide for real-time data |
| **OP1.2** | **Operations** | Surveillance & Spotting | Policy Change | BP America Paper (2006) In-Situ Burning in Inland Regions | Establish policy to have industry and government responders' better document the conduct of in-situ burns. |
| **OP2.1** | **Operations** | Ignition & Fire Boom Equipment | Research Need | USCG (2011) DWH ISPR | Enhance research and development programs on ISB to develop more robust booming systems with greater oil encounter rates as well as to expand the weather/sea state of opportunity in which ISB can effectively be used. |
| **OP2.1** | **Operations** | Ignition & Fire Boom Equipment | Research Need | BSEE. 2012 BAA Proposed Research on Oil Spill Response Operations | Improve mechanical recovery technologies to increase capture rate and capacity |

Table A-1. Data collection (Continued).

| Identified Gap - Categorization | | | | Documents Reference | Gap Identified / Recommendation |
|---|---|---|---|---|---|
| Gap – Level 1 | | Gap – Level 2 | Gap – Level 3 | | |
| **OP2.1** | **Operations** | Ignition & Fire Boom Equipment | Research Need | BSEE. 2012 BAA Proposed Research on Oil Spill Response Operations | Develop enhanced designs for containment and burning oil |
| **OP2.1** | **Operations** | Ignition & Fire Boom Equipment | Research Need | USCG (2011) DWH ISPR | Evaluate the performance of various fire boom designs. Look to improve technologies for water-cooled and reusable boom types. |
| **OP2.1** | **Operations** | Ignition & Fire Boom Equipment | Research Need | BSEE. 2012 BAA Proposed Research on Oil Spill Response Operations | Develop methods to increase the encounter rate of skimming and in situ burning operations, by increasing amount/thickness of oil on the surface (methods could involve use of chemicals, innovative mechanical systems, new operational procedures) |
| **OP2.1** | **Operations** | Ignition & Fire Boom Equipment | Research Need | Zhang, Nedwed, Tidwell, Urbanski, Cooper, Buist, and Belore (2014) One-Step Offshore Oil Skim And Burn System For Use With Vessels<br>Of Opportunity | Practical considerations for operating a floating burner system is needed; this includes safety and reliability, combustion rate and efficiency, oil viscosity and water content, total system weight, total cost, operating window (weather conditions, offshore locations ) |
| **OP2.1** | **Operations** | Ignition & Fire Boom Equipment | Research Need | JITF (2011) Oil Spill Preparedness and Response Recommendations | Develop more efficient fire boom for high sea states and faster advancing speeds |
| **OP2.1** | **Operations** | Ignition & Fire Boom Equipment | Research Need | BSEE. 2012 BAA Proposed Research on Oil Spill Response Operations | Develop enhanced designs for containment and burning oil |
| **OP2.1** | **Operations** | Ignition & Fire Boom Equipment | Research Need | JITF (2011) Oil Spill Preparedness and Response Recommendations | Research should be conducted to identify fire boom that is more efficient in higher sea states and faster advancing speeds than currently available. |

Table A-1. Data collection (Continued).

| Identified Gap - Categorization | | | | Documents Reference | Gap Identified / Recommendation |
|---|---|---|---|---|---|
| Gap – Level 1 | | Gap – Level 2 | Gap – Level 3 | | |
| **OP2.1** | **Operations** | Ignition & Fire Boom Equipment | Research Need | Buist, McCourt, Potter, Ross & Trudel (1999) Pure Applied Chemistry Vol. 71 - In Situ Burning | Develop better, longer-service-life fire containment booms |
| **OP2.2** | **Operations** | Ignition & Fire Boom Equipment | Research Need | JITF (2011) Oil Spill Preparedness and Response Recommendations | Test/verify existing fireproof booms with oil in different ice conditions trough basin and field-testing with oil. |
| **OP2.2** | **Operations** | Ignition & Fire Boom Equipment | Research Need | ICCOPR (2010) Public meeting - East | Consider aerial ignition techniques for in situ burns far offshore |
| **OP2.2** | **Operations** | Ignition & Fire Boom Equipment | Research Need | SINTEF (2006) Oil in Ice Report No. 1 | Laboratory and field-testing to verify existing and develop new igniters also including the use of surfactants for enhancing breaking water in oil emulsions. |
| **OP2.3** | **Operations** | Ignition & Fire Boom Equipment | Research Need | Zhang, Nedwed, Tidwell, Urbanski, Cooper, Buist, and Belore (2014) One-Step Offshore Oil Skim And Burn System For Use With Vessels Of Opportunity | Testing of the full scale system could achieve burn rates comparable to the capacity of oil encounter rates using booms on VOOs. Additional evaluation is warranted to further understand design parameters in order to minimize the size and weight of a full scale system |
| **OP2.3** | **Operations** | Ignition & Fire Boom Equipment | Encounter Rate | JITF (2011) Oil Spill Preparedness and Response Recommendations | Improve encounter rate for mechanical recovery |
| **OP2.3** | **Operations** | Ignition & Fire Boom Equipment | Encounter Rate | BSEE. 2012 BAA Proposed Research on Oil Spill Response Operations | Develop methods to increase the encounter rate of skimming and in situ burning operations, by increasing amount/thickness of oil on the surface (methods could involve use of chemicals, innovative mechanical systems, new operational procedures) |

Table A-1. Data collection (Continued).

| Identified Gap - Categorization | | | | Documents Reference | Gap Identified / Recommendation |
|---|---|---|---|---|---|
| Gap – Level 1 | | Gap – Level 2 | Gap – Level 3 | | |
| **OP2.3** | **Operations** | Ignition & Fire Boom Equipment | Research Need - Modeling | Buist, McCourt, Potter, Ross & Trudel (1999) Pure Applied Chemistry Vol. 71 - In Situ Burning | Verifying smoke plume computer models and confirming their capabilities to model complex terrain effects |
| **OP2.3** | **Operations** | Ignition & Fire Boom Equipment | Research Need - Modeling | SINTEF (2006) Oil in Ice Report No. 1 | Establish a laboratory methodology based on oil properties, weathering behavior, measured ignitability/burning effectiveness, measure the “window of opportunity” for in situ burning. |
| **OP2.3** | **Operations** | Ignition & Fire Boom Equipment | Research Need - Modeling | SINTEF (2006) Oil in Ice Report No. 1 | Based on the data from laboratory burnability testing on different oil types and weathering degrees, implement the ability to predict the “window of opportunity” for in-situ burning in SINTEF oil weathering models (OWM) and others. |
| **OP2.4** | **Operations** | Ignition & Fire Boom Equipment | Research Need | Goodman, Davidson, Sievert, and Wood (2014) Initiating In Situ Burning of Difficult-to-Ignite Oil Spills via an Aircraft-Deployable Igniter System | Further research is needed to quantify the amount of accelerant payload needed under any given condition. |
| **OP3.1** | **Operations** | Tactics & Support | Research Need | BSEE (2012) BAA Proposed Research on Oil Spill Response Operations | Develop enhanced designs for containment and burning oil |
| **OP3.2** | **Operations** | Tactics & Support | Research Need | Interagency Coordinating Committee on Oil Pollution Research (ICCOPR). 2010. Meeting Notes for the Public Meeting held September 16, 2010 in Washington, D.C | Investigate using unmanned aircraft and vessels to ignite slicks |

Table A-1. Data collection (Continued).

| Identified Gap - Categorization | | | | Documents Reference | Gap Identified / Recommendation |
|---|---|---|---|---|---|
| Gap – Level 1 | | Gap – Level 2 | Gap – Level 3 | | |
| **OP3.3** | **Operations** | Tactics & Support | Research Need - Residue | BSEE. 2012 BAA Proposed Research on Oil Spill Response Operations | Develop new technology for recovering sunken burn residue |
| **OP3.3** | **Operations** | Tactics & Support | Research Need - Residue | Allen (2011) Presentation | Burn Residue analysis and recovery |
| **OP3.3** | **Operations** | Tactics & Support | Research Need - Residue | Buist, McCourt, Potter, Ross & Trudel (1999) Pure Applied Chemistry Vol. 71 - In Situ Burning | Research the behavior, properties and potential effects of the residue from large burns of thick slicks of crude oil. |
| **OP3.3** | **Operations** | Tactics & Support | Residue - Policy | USCG (2011) DWH ISPR | Unburned oil or other residue from burning operations should be recovered and accounted for when evaluating the effectiveness of in situ burning. |
| **OP3.3** | **Operations** | Tactics & Support | Research Need | USCG (2011) DWH ISPR | Support R&D program to enhance aerial detection sensor capability to locate concentrations of oil necessary for ISB operations [including residue] |
| **OP3.4** | **Operations** | Tactics & Support | Research Need | USCG (2011) DWH ISPR | Need more research and development to better determine oil slick thickness |
| **OP3.4** | **Operations** | Tactics & Support | Research Need – Herder, Demulsifier | USCG (2011) DWH ISPR | Investigate the potential for enhancing burn operations with the use of herding agents and demulsifiers |
| **OP3.4** | **Operations** | Tactics & Support | Research Need – Herder | ICCOPR (2010) Public meeting - East | Investigate use of oil herders to enhance response capability for in situ burning and other uses |
| **OP3.4** | **Operations** | Tactics & Support | Research Need – Herder | Buist and Nedwed. 2011. Using Herders for Rapid In Situ Burning of Oil Spill on Open Water. | Additional research is needed to identify herding agents that perform well in warm water conditions. |
| **OP3.4** | **Operations** | Tactics & Support | Research Need – Herder | Buist and Nedwed. 2011. Using Herders for Rapid In Situ Burning of Oil Spill on Open Water. | Additional research is needed to define sea conditions when herders can be used. |

Table A-1. Data collection (Continued).

| Identified Gap - Categorization | | | | Documents Reference | Gap Identified / Recommendation |
|---|---|---|---|---|---|
| Gap – Level 1 | | Gap – Level 2 | Gap – Level 3 | | |
| **OP3.4** | **Operations** | Tactics & Support | Research Need – Herder | SL Ross (2012) Research On Using Oil Herding Agents For Rapid Response In Situ Burning Of Oil Slicks On Open Water | Commercializing the USN and silicone herders, including getting them listed on the EPA NCP Product Schedule and developing suitable application systems |
| **OP3.4** | **Operations** | Tactics & Support | Research Need – Herder | SL Ross (2012) Research On Using Oil Herding Agents For Rapid Response In Situ Burning Of Oil Slicks On Open Water | The use of the USN and silicone herders to thicken slicks in open water conditions for in situ burning should be included in plans for future offshore oil spill response field trials |
| **OP3.4** | **Operations** | Tactics & Support | Research Need – Herder | SL Ross (2012) Research On Using Oil Herding Agents For Rapid Response In Situ Burning Of Oil Slicks On Open Water | Determine how herders could be employed to improve offshore skimming encounter rates in suitable open water conditions |
| **OP3.4** | **Operations** | Tactics & Support | Research Need – Burning outside fire boom | Allen, Mabile, Jaeger, and Costanzo. 2011. IOSC ISB paper | Controlled burning outside of the fire boom can provide certain advantages, and should be studied and field tested by industry and government |
| **OP3.4** | **Operations** | Tactics & Support | Research Need – Emulsion Breaker | Buist, McCourt, Potter, Ross & Trudel (1999) Pure Applied Chemistry Vol. 71 - In Situ Burning | Continued research is warranted for the use of emulsion breakers to extend the window-of-opportunity; |
| **OP3.4** | **Operations** | Tactics & Support | Research Need – Surfactant | SINTEF (2006) Oil in Ice Report No. 1 | Laboratory and field-testing on the use of surfactants for enhancing breaking water in oil emulsions. |
| **OP3.4** | **Operations** | Tactics & Support | Research Need – Emulsions | Allen (2011) Presentation | Burning of emulsions |
| **OP4.1** | **Operations** | Training | Policy - Data Collection | USCG (2011) DWH ISPR | Develop a program to capture operational information and key lessons learned from the Deepwater Horizon incident and other tests and incidents involving ISB |

Table A-1. Data collection (Continued).

| Identified Gap - Categorization | | | | Documents Reference | Gap Identified / Recommendation |
|---|---|---|---|---|---|
| Gap – Level 1 | | Gap – Level 2 | Gap – Level 3 | | |
| **OP4.1** | **Operations** | Training | Policy - Data Collection | Mendelssohn, Hester, and Pahl (1996) LSU Tech Report Environmental Effects And Effectiveness Of In Situ Burning In Wetlands: Considerations For Oil Spill Cleanup | Recommend that trustee agencies work together to provide a central location where reports, data, and photographs would be archived for each spill and subsequent monitoring activities. |
| **OP4.1** | **Operations** | Training | Policy - Data Collection | Mendelssohn, Hester, and Pahl (1996) LSU Tech Report Environmental Effects And Effectiveness Of In Situ Burning In Wetlands: Considerations For Oil Spill Cleanup | Agencies or their delegates should evaluate and synthesize this information on a yearly basis and provide cumulative reports describing current knowledge of oil spill cleanup technology [in wetlands]. |
| **OP4.1** | **Operations** | Training | Policy – Data Collection | BP America Paper (2006) In-Situ Burning in Inland Regions | Establish policy to have industry and government responders’ better document the conduct of in-situ burns. |
| **OP4.2** | **Operations** | Training | Preparedness | JITF (2011) Oil Spill Preparedness and Response Recommendations | Develop training requirements and a training program for in situ burn responders and supervisors. |
| **OP4.2** | **Operations** | Training | Preparedness | Mabile (2012) The Coming of Age of Controlled In-Situ Burning: Transition from Alternative Technology to A Conventional Offshore Spill Response Option | Need to develop contingency plan awareness training for ISB |

Table A-1. Data collection (Continued).

| Identified Gap - Categorization | | | | Documents Reference | Gap Identified / Recommendation |
|---|---|---|---|---|---|
| Gap – Level 1 | | Gap – Level 2 | Gap – Level 3 | | |
| **OP4.2** | **Operations** | Training | Policy – Preparedness | Allen, Mabile, Jaeger, and Costanzo. 2011. IOSC ISB paper | Training requirements; burn team, spotters, |
| **OP 4.2** | **Operations** | Training | Policy – Preparedness | Allen, Mabile, Jaeger, and Costanzo. 2011. IOSC ISB paper | Standards needed for ISB responders |
| **OP4.1** | **Operations** | Training | Policy - Data Collection | Mendelssohn, Hester, and Pahl (1996) LSU Tech Report Environmental Effects And Effectiveness Of In Situ Burning In Wetlands: Considerations For Oil Spill Cleanup | Recommend that trustee agencies work together to provide a central location where reports, data, and photographs would be archived for each spill and subsequent monitoring activities. |
| **OP4.2** | **Operations** | Training | Policy – Preparedness | USCG (2011) DWH ISPR | Need to enhance SMART monitoring technologies and protocols in offshore environments |
| **OP4.2** | **Operations** | Training | Policy – Preparedness | JITF (2011) Oil Spill Preparedness and Response Recommendations | Development of a standard training course material may be desirable. |
| **OP4.2** | **Operations** | Training | Policy – Preparedness | USCG (2011) DWH ISPR | Training, field exercises, and field experience are necessary to maintain proficiency of spotters, logistical and operational coordinators, pilots, and SMART teams. |
| **OP4.2** | **Operations** | Training | Policy – Preparedness | JITF (2011) Oil Spill Preparedness and Response Recommendations | Supplement with routine practice in the preparation and approval processes as part of drills and exercises. |
| **OP4.2** | **Operations** | Training | Policy – Preparedness | JITF (2011) Oil Spill Preparedness and Response Recommendations | Advanced personnel training opportunities for in situ burn operations should be organized. |

Table A-1. Data collection (Continued).

| Identified Gap - Categorization | | | | Documents Reference | Gap Identified / Recommendation |
|---|---|---|---|---|---|
| Gap – Level 1 | | Gap – Level 2 | Gap – Level 3 | | |
| **OP4.2** | **Operations** | Training | Policy – Preparedness | JITF (2011) Oil Spill Preparedness and Response Recommendations | Workshops and other learning opportunities (regulatory agencies and communities) be coordinated to facilitate sharing of the extensive scientific data (both lab and field based) as well as the value and tradeoffs inherent in the use of in situ burning as a response tool. |
| **OP4.2** | **Operations** | Training | Policy – Preparedness | US Arctic Research Commission (2004) | Use spills of opportunity for training and controlled burns as research tools |
| ISB Safety Recommendations | | | | | |
| **S1.1** | **Safety** | Responder Health | Human Health Monitoring | National Commission to the President (2011) Deepwater Horizon Report | Need long-term monitoring of Deepwater Horizon responders' health and health of community in the most affected coastal areas. |
| **S1.1** | **Safety** | Responder Health | Human Health Monitoring | EPA (2011) Draft Oil Spill Research Strategy | Continue the NIEHS Gulf Coast Cohort study investigating the health effects of exposed cleanup workers |
| **S1.2** | **Safety** | Responder Health | Human Health Monitoring | National Commission to the President (2011) Deepwater Horizon Report | Consider value of taking biological samples from cleanup workers before or immediately after their exposure to oil to establish baseline from which to conduct research into long term health impacts. |
| **S1.2** | **Safety** | Responder Health | Human Health Monitoring | McCoy and Salerno (2010) | More information is needed to best protect the health of affected populations in the contexts of the Deepwater Horizon oil spill and future public health disasters. |
| **S1.3** | **Safety** | Responder Health | Human Health Monitoring | Aquilera, Mendez, Pasaro, and Laffon (2010) | Establish detailed intervention protocols that include some mechanisms to detect and control the possible harmful effects that exposure can induce, including performing the immediate collection of biological samples from the beginning of the cleanup work, in order to establish the levels of individual internal exposure effects at the acute and chronic level, especially those related to genotoxicity. |
| **S1.4** | **Safety** | Responder Health | Human Health Monitoring | USCG (2011) DWH ISPR | Need monitoring for potential health effects of air pollutants from burning oil for workers as well as long range |

Table A-1. Data collection (Continued).

| Identified Gap - Categorization | | | | Documents Reference | Gap Identified / Recommendation |
|---|---|---|---|---|---|
| Gap – Level 1 | | Gap – Level 2 | Gap – Level 3 | | |
| **S2.1** | **Safety** | Public Health | Human Health Monitoring | National Commission to the President (2011) Deepwater Horizon Report | Need to improve understanding of long term health impacts of oil spills. |
| **S2.1** | **Safety** | Public Health | Human Health Monitoring | EPA (2011) Draft Oil Spill Research Strategy | Continue the NIEHS Gulf Coast Cohort study investigating the health effects of exposed gulf residents |
| **S2.2** | **Safety** | Public Health | Human Health Monitoring | National Commission to the President (2011) Deepwater Horizon Report | Need to research the causal or correlative relationships between chemical (i.e., oil and dispersants) exposure and human health. |
| **S2.3** | **Safety** | Public Health | Human Health Monitoring | EPA (2011) Draft Oil Spill Research Strategy | Determine the cardiovascular effects associated with exposure to smoke plumes from in situ burns |
| **S2.3** | **Safety** | Public Health | Human Health Monitoring | EPA (2011) Draft Oil Spill Research Strategy | Determine the effects of dermal contact with oil |
| **S2.3** | **Safety** | Public Health | Human Health Monitoring | EPA (2011) Draft Oil Spill Research Strategy | Determine if neurological effects when exposed to a mixture of hydrocarbon vapors is worse than the sum of the effects of exposure to individual vapors |
| **S2.3** | **Safety** | Public Health | Human Health Monitoring | EPA (2011) Draft Oil Spill Research Strategy | Determine the dose-response function for acute exposures to hydrocarbon vapors |
| **S2.4** | **Safety** | Public Health | Human Health Monitoring | NRT S&T Committee (1995) NRT Paper | Develop accurate data on how far downwind PM-10 generated from an oil spill is measurable |
| **S2.5** | **Safety** | Public Health | Human Health – Seafood Safety | Gohlke et al. (2011) A Review of Seafood Safety after the Deepwater Horizon Blowout. | Determine Seafood Safety Consumption standards for public health (including effects from ISB) |
| **ISB Research Recommendations** | | | | | |
| **R1.1** | **Research** | Tank Tests & Field Trials | | EPA (2011) Draft Oil Spill Research Strategy | Conduct a study comparing environmental footprints of various response technologies |

Table A-1. Data collection (Continued).

| Identified Gap - Categorization | | | | Documents Reference | Gap Identified / Recommendation |
|---|---|---|---|---|---|
| Gap – Level 1 | | Gap – Level 2 | Gap – Level 3 | | |
| **R1.1** | **Research** | Tank Tests & Field Trials | | National Commission to the President (2011) Deepwater Horizon Report | Need further research into clean-up technology including in situ burning techniques |
| **R1.1** | **Research** | Tank Tests & Field Trials | | US Arctic Research Commission (2004) | Use spills of opportunity for training and controlled burns as research tools |
| **R1.1** | **Research** | Tank Tests & Field Trials | | NRT Science and Technology Committee (2000) Fact Sheet: Fact Sheet: Residues from In situ Burning of Oil on Water January, 2000 | Field trials and study of actual spills where ISB is conducted are needed to determine whether or not the small-scale test data and predictive models developed to date apply to large burns. Results from these test would be used to refine models that predict residue behavior. |
| **ISB Policy Recommendations** | | | | | |
| **P1.1** | **Policy** | Simultaneous Operations | | National Commission to the President (2011) Deepwater Horizon Report | Controlled ISB is generally conducted concurrent with and simultaneous to dispersant and mechanical recovery operations. |
| **P1.1** | **Policy** | Simultaneous Operations | | Houma ICP Aerial Dispersant Group. 2010. After Action Report: Deepwater Horizon MC252 Aerial Dispersant Response. | Need additional research to further develop a consistent response strategy for using aerial dispersants in conjunction with mechanical recovery and in- situ burning that is refined, communicated, coordinated and executed to maximize the removal of oil from surface waters during a response |
| **P1.1** | **Policy** | Simultaneous Operations | | U.S. Coast Guard. 2011. On Scene Coordinator Report: Deepwater Horizon Oil Spill. | Recommendations for managing and coordinating multiple response tactics 5-50 NM offshore |
| **P1.1** | **Policy** | Simultaneous Operations | | Allen, Mabile, Jaeger, and Costanzo. 2011. IOSC ISB paper | Communications requirements and methodology (air to ground observers, etc.) |

Table A-1. Data collection (Continued).

| Identified Gap - Categorization | | | | Documents Reference | Gap Identified / Recommendation |
|---|---|---|---|---|---|
| Gap – Level 1 | | Gap – Level 2 | Gap – Level 3 | | |
| **P1.1** | **Policy** | Simultaneous Operations | | Houma ICP Aerial Dispersant Group. 2010. After Action Report: Deepwater Horizon MC252 Aerial Dispersant Response. | Operating zone establishment guidelines for burn boxes/circles, recovery boxes and application zones |
| **P1.1** | **Policy** | Simultaneous Operations | | Allen, Mabile, Jaeger, and Costanzo. 2011. IOSC ISB paper | Better manage both spatial and temporal aspects of all response operations in order to ensure one action would not reduce the effectiveness of the other |

# APPENDIX B. BIBLIOGRAPHY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